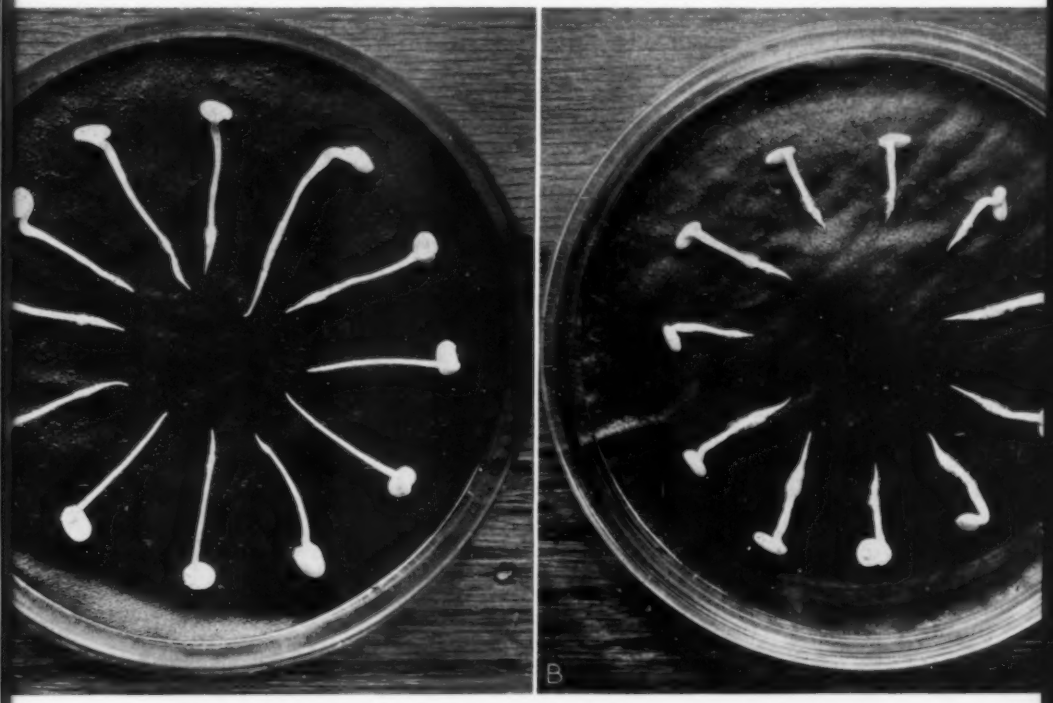
PEARL

# The Journal of HEREDITY



DEMONSTRATING A GROWTH-RATE GENE IN THE LUPINE

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VOLUME 26 DECEMBER, 1935 NUMBER 12

# The American Genetic Association

***An incorporated organization devoted to promoting a knowledge of the laws of heredity and their application to the improvement of plants, animals, and human racial stocks***


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The JOURNAL OF HEREDITY is published monthly by the AMERICAN GENETIC ASSOCIATION at 1918-32 Harford Avenue, Baltimore, Md., and Victor Building, Washington, D. C. Address all communications regarding editorial matters to Room 308, Victor Building, Washington, D. C. Communications regarding the business management of The JOURNAL OF HEREDITY may be addressed to the publication office, 1918-32 Harford Avenue, Baltimore, Md., or to the Victor Building, Washington, D. C. Entered as second-class matter February 24, 1923, at the postoffice at Baltimore, Maryland. Acceptance for mailing at the special rate of postage provided for in section 1103, Act of October 3, 1917, authorized December 20, 1918.


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$3.50 a Year. 35c the Copy. Prices of back numbers on application.

The

# Journal of Heredity

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Members engaged in teaching genetics or related subjects are cordially invited to use the Journal as a supplementary text in their classes. The rapid progress of the science, after being so long neglected, is one of the most important and attractive features to place before students. Even the latest textbooks are soon outdated, but they become more interesting as the historical background of the discoveries described in the Journal of Heredity.

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**EIGHTEENTH CENTURY JAPANESE MOUSE MUTATIONS**

**Frontispiece**

Illustrations from "Chingan-Sodategusa," a Japanese mouse-breeding guide published in 1787. Three grades of piebald are shown (*A, B, D*) and at *C* a dwarf, (left) and a black eyed white (right). The directions given in this booklet for breeding various color patterns in the mouse do not all fit into the modern genetic scheme, but many of them prove to be well founded by modern genetic research. The figures reproduced above appear on pages 12 and 13 of the original booklet.

# AN EIGHTEENTH CENTURY JAPANESE GUIDE-BOOK ON MOUSE-BREEDING

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WHILE looking for old records of mutant strains of the mouse, I came across a copy of "Chingan-sodategusa" ("The breeding of curious varieties of the mouse") in the Tokyo Imperial Library. More recently, another copy of the same book came to the hand of Dr. Nakamura of our laboratory and was kindly shown to me. It is quite a small book, 156 mm. long and 104 mm. broad, having fourteen pages in all, and was written in 1787 by one Chôbei Zeniya, a resident of Kyoto. The career of the author is now obscure; but judging from his name, he was probably a man engaged in the money exchange business.

The book begins with a chapter on the origin of the albino mouse in Japan, and contains various accounts of the technique of the breeding and rearing of the mouse. The most interesting of all are the descriptions of various mutants of the mouse and the discussion of their mode of inheritance. There are, naturally, some ridiculous mistakes in the author's theories and a good many meaningless and traditional notes. However, the main part remains worthy of our notice even with our knowledge of modern science, as it rests on substantial experiments. I am confident that the main part of the book merits translation into English as an old record of mutant strains of the mouse and of their mode of inheritance. This I am presenting below, the translated passages being in italics, and following them some elucidations of sentences that do not bear direct translation and some remarks when they seem necessary. For the sake of brevity, the preface and the chapters relating to the technique of caring for the mouse are omitted.

## EXCERPTS FROM "CHINGAN-SODATEGUSA"

### Origin of the Albino Mouse in Japan

*In one of our proverbs a good diligent clerk or faithful servant is compared to a white mouse; the reason of which is as follows: A Chinese Buddhist-priest, In-gen by name, who afterwards erected the Obaku Temple (at Uji near Kyoto), came over from China in the autumn of the 3rd year of Shô-ô, in the reign of Gokômyô-in, the one hundred and eleventh Emperor (1654). At that time he brought with him a pair of black-eyed white mice as his pets. In Japan, the followers of the priest daily increased in number and his temple became full of pilgrims. Then the mice were given to an enthusiastic applicant whose earnest request the priest could not refuse. The man took good care of the mice, and the more he prized them the richer he became. Moreover, his posterity enjoyed long prosperity, etc.*

Concerning the origin of the oriental tame mouse (*Mus bacterianus* var. *albula*) and its famous variety, the so-called "dancing mouse" (*Mus bacterianus* var. *rotans*), it is uncertain whether they originated in Japan or in China, or some other place in Asia. The dancer variety is called "Chinese" or more often "Japanese" dancing mouse. Brehm (1890), who first introduced the dancer in Europe, applied the name "Japanese" to that mouse

merely because of the ill-grounded communication of an animal dealer who brought the mouse from Japan. Subsequently, several investigators tried to verify the real origin of the variety. Yerkes wrote in 1907 to two Japanese zoologists, Mitsukuri and Hatai, for information about the tame mice in Japan. But he could only find out that the albino mouse was called "Nankin-nezumi" in Japan, the name implying that the mouse had been introduced from China. On the other hand, he ascertained that the Chinese deny its origin in China and call it "foreign mouse." Thus Yerkes vaguely concluded that the race had been originated first in China, and was introduced into Europe and America through Japan. Fortuyn (1912), from a morphological study of the dancer, pointed out that the race was probably derived from the common Asiatic species, *Mus bacterianus* (*wagneri*), and not from European *Mus musculus*. However, he did not compare the variety with other Asiatic species such as *Mus molossinus* and *Mus caroli* which are found in Japan. Sharp (1912)* suggested that the dancer was derived, at least in part, from *bacterianus* of Tibet. However, there still remain some authors who believe that the mouse originated in Japan, for on a Netsuke or toggle kept in the Louvre are carved several mutants of the tame mouse (Schulumberger, 1894), and Masateru, the carver, lived during the last part of the eighteenth century and the first part of the ninteenth century—this fact indicates that the mouse was already common in Japan at that time.

The above-cited old record of the origin of the tame mouse in Japan merits special attention, although its authenticity is somewhat doubtful. At any rate it seems fairly certain that the tame mouse of Japan came from China, wherever its native place may have been.

**AN ALBINO MOUSE**

**Figure 1**

Illustration of a boy holding an albino mouse appearing on page 5 of "Chingan-Sodategusa." It appears from this early record of the tame mouse in Japan that it came from China at least as early as 1654. The wild species from which the tame mouse originated has not been exactly determined.

### Mutants and Breeding Directions

*Case 1: When the black spotted mouse is mated with its own kind, black spotted offspring are usually obtained. But, in a few cases, lilac colored mice may be found.*

Non-agouti spotted mice mated *inter se* breed true in the general case. Only when both parent mice carry the

*Cited from Keeler's "The laboratory mouse." 1931, p. 16.

pink-eye factor (*p*) in heterozygous condition, some of their offspring may be lilac-colored, as *pp* changes non-agouti to lilac.

---

*Case 2: The cross between the red-eyed albino female mouse and the black spotted male mouse produces self-colored black mice. If one of the females among the offspring is crossed with a black spotted father, there will result black mice with white bellies or breasts marked with a white crescent.*

The specification of the sex in the above description is unnecessary from the present genetic viewpoint. However, the import of the description may be explained as follows: if the albino parent in this cross happens to be of the genetic constitution *ccaa - - - - SS*, it will throw black young in the $F_1$ generation. Next, if such $F_1$ animals (*Ss*) are back-crossed with the *ss* parent, self-colored and spotted are expected in equal numbers in $F_2$. But, actually, the coloration of *ss* animals shows gradations between solid colored and white with dark eyes, so that there may result such individuals as are indicated in the description.

---

*Case 3: From among black spotted mice, choose a pair of very slightly colored animals, and cross them. From among this offspring pick out the least colored individuals and cross them. By repeating this procedure you may eventually get black-eyed white mice. These are the ones that people prize highly as "white mice," and are to be distinguished from red-eyed whites.*

It seems interesting to recall that this record of the technique of selection of color-patterns precedes Castle by about one hundred and twenty-five years.

---

*Case 4: Black-eyed white mice always breed true when mated with their own kind. If one of the offspring of such a cross mates with a male of any color, their young inherit the color of the sire only on the head, while other part of the body remains white as in the dam.*

The so-called black-eyed white mouse in this book apparently differs from the real black-eyed white mouse which always carries the gene *W*, and is represented as *Wwss*. *WW* animals are known to die from anemia shortly before or after birth, and the black-eyed white does not breed true. Thus with the conception of the black-eyed white parent as one to be selected from *aass* animals in the way stated in Case 3, it is difficult to explain the above description on a genetic basis.

---

*Case 5: If a female black-spotted mouse is mated with a black-eyed white male, she sometimes bears young with lilac heads.*

If both parents in this cross carry the pink-eye factor (*p*) in the heterozygous condition, *pp* individuals with lilac coat may be expected among their offspring.

---

*Case 6: When a black-eyed white mates with lilac she produces young with eyes of ruby (?) color.*

So and Imai (1926) have reported the ruby eye (*p'*) in the oriented tame mouse beside the pink eye (*p*). *P*, *p'* and *p* are triple-alleomorphs, and are dominant in accordance with this order. If the black-eyed white parent happens to carry the *p'* factor in heterozygous condition, there may be seen some ruby eye individuals (*p'p*) in the offspring.

---

*Case 7: When two pinks mate, they give pink. If one of the sons of such cross is back-crossed to the mother, "Azami" is produced. This color variety is rarely known.*

"Azami" means dark pink. The "pink" probably represents some coat

color of the brown series. By association with a dilute or an eye-color factor brown readily takes a darker or a lighter tone.

**"Mame-jiro" and "Mame-buchi"**

*In Mame-nezumi (dwarf?) pregnant females must not be kept apart from males, as separation delays the next bearing.*

No further description on "Mamenezumi" is found through this book. The illustration (Frontispiece) shows that the breed has a considerably smaller body than the other varieties. This fact together with the name (Mame-small, nezumi-mouse) shows strongly that it is nothing but the mutant "dwarf" in modern mouse genetics. It may be questioned whether "Mame-nezumi" might not mean the mouse, while the other varieties mentioned in this pamphlet are mutants of the rat. Against this idea it may be pointed out that: (1) The old Japanese word for the mouse was "Amakuchi-nezumi" and there is no evidence that "Mame-nezumi" has ever been used in its place; (2) The size of the animal in proportion to the child in the illustration (Figure 1) indicates that the animal is too small to be a rat; (3) Asymmetrical piebald is much rarer in the rat than the mouse, in the illustration a typical asymmetrical piebald is presented.

If "Mame-nezumi" is the dwarf, "Mame-jiro" and "Mame-buchi" seem to correspond with albino dwarf and spotted dwarf respectively.

On the last page there is an announcement that the second volume of this book will be soon published with the title "Shinsen-sansoroku" (Descriptions of three novel varieties of mice), in which the author proposes to describe the "red," "light yellow" and "lilac yellow" mice, and to disclose the secret of their breeding. This second volume would be no less interesting than the volume here described, but it is inaccessible to me as yet. It is even uncertain whether the volume was ever published.

**U. S. Hunts Herdsman of Livestock Genes**

The United States Civil Service Commission has announced an open competitive examination as follows: Senior Animal Husbandman (Genetics).

Applications for the position of senior animal husbandman (genetics) must be on file with the U. S. Civil Service Commission, Washington, D. C., not later than January 6, 1936.

The entrance salary is $4,600 a year, subject to a deduction of 3½ per cent toward a retirement annuity.

Applicants must have been graduated with a bachelor's degree from a college or university of recognized standing upon the completion of at least 118 semester hours. Except for the substitution provided below, they must have had six years of progressive responsible research experience in some phase of animal genetics. Each year of postgraduate study, the major portion of which was in animal genetics, will be accepted in lieu of one year of the required experience up to a total of three years. Additional credit will be given applicants who have had research experience with problems in livestock breeding.

Full information may be obtained from the Secretary of the United States Civil Service Board of Examiners at the post office or custom house in any city which has a post office of the first or the second class, or from the United States Civil Service Commission, Washington, D. C.

# A YEAR OF GERMAN STERILIZATION

## 205 Eugenics Courts Yield 84,526 Sterilization Orders in 1934

DESPITE modern facilities for rapid communication it has proved something of a problem to obtain information regarding the results of the first year's operation of the German Law for the Prevention of Hereditary Diseases, which went into effect on January 1, 1934. Reactions in favor of, or in opposition to, the Nazi regime in Germany are usually violent. As a consequence facts unadorned with emotional draperies are somewhat at a premium. A request to the Eugenics Information Bureau at Berlin brought assurances that official statistical material would be forthcoming, but nothing has been received. Information regarding the law published in American newspapers has been conflicting and difficult to verify. In one instance, discussed below, a statement regarding the total number of sterilizations taking place seems to have been seriously in error, apparently through mistranslation of a German article on the subject.

Under any circumstances an experiment such as that undertaken by the German government would be expected to produce rather violent reactions. On account of the racial bias of the German government, the temptation is great for critics of the law to picture it as a punitive measure used principally against those who, lacking the requisite "Aryan blood," are *ipse facto* "hereditarily defective." Certain groups that on other grounds have found themselves in opposition to the Nazi government have long been opposed to sterilization. The temptation to kill two birds of controversy at once makes a judicious attitude doubly difficult. On the other hand, it is hardly to be expected that official statements of the German government regarding the law will ignore such criticism, and there may be a tendency to counter them with an excess of enthusiasm. Thus a really objective view of what has happened is difficult to get, and must lie somewhere in the no-man's land between the "pros" and "cons."

The opponents of the present German government can hardly escape the feeling that official statistics have been "doctored" in some way to present a pleasing picture. While there is no way to prove that such may not be the case, a certain amount of indirect evidence has been obtained which strongly supports the view that the German authorities have made a sincere attempt to apply the principles of the sterilization law in a just and enlightened manner. No serious evidence that it has been used improperly as a "racial purifier" has been noted. The following information regarding the organization of eugenic courts, and statistics regarding the number of sterilization cases in 1934, are taken from two articles by Amtsgerichstrat Massfeller of the Imperial Prussian Ministry of Justice, published in *Deutche Justiz* for March 15, 1935, and for May 24, 1935. Following this are notes from various other sources on the Sterilization Law. These indicate the trend of thought on the part of German legal and medical authorities regarding the law.

Since January, 1934, 205 eugenics courts and 26 superior eugenics courts of appeal have been established in the German Empire. Hundreds of physicians and legal experts have been engaged in working out the details of the administration of the law. The organization of these courts and the limitations of their jurisdiction was set forth in the original law. In various parts of Germany different methods of administration have been worked out. Thus, in Prussia, Bavaria and Saxony, a eugenics unit is attached to each civil court. In Wurttemburg and Thuringia a larger number of eugenics courts was

established. This has the advantage that in Wurttemburg each judge deals with a smaller area so that he has an easy access to the social conditions of those who are brought before him.

In the early months of 1934, it was necessary to establish training schools all over Germany to acquaint physicians and lawyers with the scope of the law and with the essential facts on which its operation depended. Specialists in law, medicine and genetics conducted these courses. The Health Departments all over Germany were also instructed in the necessary specialized information; this was essential because hereditary diseases were made notifiable in Germany, just as are contagious diseases in all civilized countries. By the end of February, 1934, the courts began to hold their first sessions. The work during the early months was relatively light and much time was spent in developing methods of procedure. The rapidity with which the eugenics courts have begun to function has varied considerably in various parts of Germany. The greatest activity has been in the jurisdictions of Karlsbad and Hamburg. No conclusion regarding the distribution of hereditary deficiencies can be reached by a study of relative sterilization rates during 1934 in various parts of Germany.

During the first year an average of about 75 per cent of the cases brought before the eugenics courts were disposed of. This high percentage is to be accounted for largely by the fact that during the early months the unquestionable, institutionalized cases were brought to decision. In ensuing years the percentage of actions which culminate in sterilization will be less. It is hoped by the German authorities that it will usually be possible to settle these cases definitely without long drawn out proceedings. The adverse effects on health of such actions are obvious, especially in cases of mental instability.

### "Borderline Cases"

Massfeller's discussion of borderline cases is especially interesting in connection with the administration of the law as a punitive measure. Following is a free translation of his remarks on these points:

> That the law and its associated regulations gave rise to disputes is understandable especially since no precedent existed, but instead work from the ground up was required, and, in the interest of the German people, speed was essential. It is satisfying that disputes did not affect the essential principles of the law. Naturally questions of principle did arise; one need only to mention the evaluation of moral degeneracy; the consideration of the probabilities which exist for occurrence in offspring of serious mental or physical stigmata; whether, in the case of unquestionable hereditary diseases, for particular reasons, sterilization should be abandoned. However the greatest difficulty lay in the so-called "borderline cases," when diagnosis was not absolutely clear-cut. One needs only to consider the differentiations of manic-depressive psychosis as opposed to the "cycloid temperment" of Kretschmer. Also in other disease forms, especially congenital feeble-mindedness and schizophrenia, doubtful cases arise. Borderline cases require careful analysis. When an unequivocal decision whether hereditary disease exists is impossible, even in the light of examination by psychiatrists, there can be no doubt as to the eugenic Court's decision, since the law states: "Sterilization requires that the illness be unquestionably determined by a physician approved by the State, although it may be sporadic, from a hidden source." Equally clearly it is stated in paragraph 1, that only those may be sterilized who themselves are suffering from one of the conditions specifically named in the law.* That means that sterilization of carriers is illegal; those recessive carriers who are normal in appearance cannot be sterilized if the disease makes its phenotypic appearance in the children; even if the recessive carrier himself desires sterilization. Again, the lawyer is forbidden to widen the circle of those subject to sterilization; the psychopathic individual who cannot be proven to have one of the designated conditions cannot be sterilized. In this case as well, the duty of the eugenic judge is clearly stated. It is idle to question whether the law may be applied

*The German law specifies nine grounds for sterilization: (1) hereditary feeblemindedness, (2) schizophrenia (dementia praecox), (3) manic-depressive insanity, (4) Huntington's chorea, (5) hereditary epilepsy, (6) hereditary blindness, (7) hereditary deafness, (8) gross bodily malformation, (9) severe alcoholism (psychopathic).

by analogy, or whether an amplification "in the spirit of the law" is permitted. * * * *

In the form of the eugenic court proceedings the law givers have allowed intentionally the greatest latitude. The spirit of guarding the legal rights of the individual is rigorously adhered to. The subject of hereditary disease has the same right as others involved in legal proceedings to state his own case. This implies that he must be instructed in the most important factors involved. The rights of the patient to a legal hearing would be infringed if he received the first information of the intention to sterilize, after examination by the circuit physician in the order of the judge, without an opportunity being given for his own defense. Such a result would also be directly opposed to the spirit of the legislature. It is repeatedly stated, and rightly so, that the protection against wrong decisions be assured, since the institution of proceedings must be accompanied by a medical certificate, and in the first, as in the second instance, two physicians must act as judges, so that for the individual involved in this all-important matter, an overstepping should be impossible. The individual is entitled to legal rights, the eugenically unfit certainly more than the law breaker. He has the right that sterilization be considered only as last resort in light of the people's good.

In those cases in which, according to the judgment of the presiding judge, the possibility of a misunderstanding with the accused is not absolutely shut out, the following procedure has been found by many judges to be expedient. As soon as the notification of the official physician or presiding officer for legal sterilization is made, this is given to the patient with information regarding the illness upon which the injunction is based. This information goes, as does other information from the eugenic courts, in envelopes which do not carry the name "eugenic court;" usual civil court stationery may be used. The patient also receives information regarding the plan of trial. If the judge thinks that personal appearance is required, he is summoned. He receives in this case reimbursement for necessary traveling expenses. If his presence is not thought essential, he is notified that this is so and traveling expenses are not paid.

In many cases, of course, the personal appearance of the patient cannot affect the judgment. For instance, in schizophrenia a departure from the normal is often not evident. Also more time would be needed and the number of cases in a given time diminished. However, these disadvantages are more than offset by the fact that the patient has the feeling that his case is not acted on superficially.

In these cases, as well as in those in which the patient is represented by a parent or guardian, the judges and physicians must bear in mind that upon the management of the law its judgment by the people will rest.

In a later article Dr. Massfeller gives official statistics summarizing the sterilization decisions during the first year. To December 31, 1934, in the 205 lower eugenics courts in Germany, 84,256 sterilization actions were entered. (No information regarding the actual number of sterilizations performed is available, but at the end of the year it appears to have been 20 to 40 per cent of the total actions disposed of by the courts.) The proportion of the two sexes subject to sterilization proceedings was about equal: 42,903 men and 41,052 women. This amounts to one proposal of sterilization for each 771.2 inhabitants of the German Empire.

**Three-Quarters of Cases Disposed Of**

By December 31, 1934, 64,499 of the sterilization actions had been disposed of by the courts. In 56,244 cases sterilization was ordered,—in 3,692 cases it was refused, 4,563 cases were disposed of through withdrawal of the action, reference to another court, etc., and 15,463 cases were still pending at the end of the year. On the average, 75 per cent of the cases presented to the eugenics courts have been settled. 93.8 per cent were ordered sterilized, and 6.2 per cent were refused.

Appeals from the decisions of the lower eugenics courts were taken in 8,219 cases (14.6 per cent). At the end of the first year 5,245 of these appeals had been disposed of. In 377 of these cases (7.2%) the appeal against the decision of the lower court was upheld. In the remaining 4,559 cases the decision of the lower court was upheld by the higher court.

In 438 cases where sterilization was refused by the lower eugenics court the decision of the court was appealed. In 179 of these cases the refusal of sterilization by the lower court was set aside and sterilization ordered. In 108 cases the decision of the lower court was upheld. The remaining appeals were still pending.

Another article giving information on activity of the eugenics courts in the Kiel and Hamburg region was the basis for a

dispatch to the *New York Times* on February 4, 1935. This article, which we are informed was based on a statement appearing in the *Juristische Wochenschrift* for January 5, 1935, alleges that between 180,000 and 200,000 sterilizations had been performed in Germany in 1934. Reference to the original article suggests that an error in translation had been made. Dr. Grunau, judge of the Superior Court of Kiel, the author of the article, presents figures for the Kiel-Hamburg region. Following these he estimates, on a pro-rata population basis, that between 180,000 and 200,000 sterilization orders would have been entered for the entire German empire were the ratios the same as in the Hamburg-Kiel region ("wenn man diese Zahlen auf das ganze Reich übertragt * * * so waren im Jahre 1934 bei Zugrundelegung Hamburgischer Zahlen 180,000 bis 200,000 Unfsruchtbarmachungen angeordnet worden sein"). The article goes on to say that about 25 per cent of the actions before eugenics courts had culminated in actual sterilization. This would mean that between 35,000 and 50,000 sterilizations had actually been performed during the first year of the operation of the new law. This is in good agreement with the other published figures.

In Kiel, according to Grunau's figures, about 1,500 sterilization suits were brought in the eugenics courts in 1934. Of these cases, 1,250 eventuated in sterilization orders, and in 550 cases the operations have been performed. In Hamburg, to the twelfth of December, 1934, 2,938 actions have come before the eugenics courts; 2,194 sterilization orders have been entered by the court, and 1,439 operations have been performed. It is on the basis of these 2,194 sterilization orders that the estimate of 180,000 to 200,000 such orders for the entire German empire is based. The statement later in the article that 25 per cent of the orders have culminated in actual sterilizations evidently is not an estimate from the Hamburg figures, where nearly half of the judicial actions have resulted in sterilization.

This is in fairly close accord with a statement made before the April (Berlin) meeting of the Deutsche Gesellschaft fur Chirurgie, by Dr. H. J. Bauer of Breslau. His estimate is that about 45,000 sterilizations have actually taken place. In the six thousand cases on which these estimates are based, 96 per cent of the sterilizations were performed because of grave mental defect. The bodily malformations supplied only 0.1 per cent of cases. The ages at which the maximum number of sterilizations occurred both in the Bauer and the Grunau figures is in the third and fourth decades of life. In the Bauer series of 6,062 cases, there were 7 deaths due to the following causes: pneumonia (3), cardiac weakness (1), myocarditis (1), epilepsy (1), erysipelas (1). The question of technique was also discussed extensively at this meeting.

In the Hamburg series less than half the sterilizations were for inherited feeble-mindedness (45.7 per cent), schizophrenia accounted for nearly a third (26.6 per cent). Epilepsy was the basis of 17.8 per cent of the decisions and other causes represented much smaller percentages (alcoholism 2.9%, manic-depressive insanity 2.9% and other hereditary sicknesses less than 1%).

### Medical Views

The Berlin Medical Society also presented a symposium on the subject (as reported in the *Journal of the American Medical Association* for April 1, 1935—Volume 104, Page 209), which gives some interesting information on the legal and medical aspects of the law in operation. The most effective methods of accomplishing human sterilization, and difficulties which are encountered in practice in dealing with a large number of such operations occupied much of the time of the meeting. Thus some of those who have been legally certified for sterilization by a eugenics court have been found to be suffering from abdominal diseases such as cancer, and one case was found to be lacking a uterus previous to operation!

Another interesting question raised is the responsibility of the physician when the sterilization operation discloses other abdominal conditions that require surgical intervention. Since the patient is unconscious, permission cannot be obtained to perform additional surgery, no matter how important. The German law definitely specifies the operative procedure to be followed, which procedure is in some cases not the most desirable from the point of view of the surgeon and of the patient.

Statistics covering the number of cases appearing before the eugenics courts are summarized:

In the eugenics court of Wupptertal (Rhineland), during the first year of its existence, approximately 1,000 petitions for sterilization work were filed. In about 800 cases the petitions were granted and about 600 interventions have been carried out. In the eighteen eugenics courts in Thuringia (central Germany) 3,178 petitions for sterilization have been filed, 2,472 of which have been heard before these courts. In 2,303 cases the petition was granted and in 1,395 cases sterilization has been carried out.

The eugenics courts have been faced with perplexing problems. What is to be the policy where special abilities are associated with inherited defects? What of borderline cases, where the presumption of morbid heredity is strong but not absolutely conclusive? The decisions thus far rendered seem conservative:

The body having jurisdiction opposed in one instance the enrolling of a peasant family in the so-called Erbhofrolle (whereby a farm becomes indivisible and is always handed down to the oldest child), because for generations tuberculosis had been widely prevalent in this family, and advised that the farm be divided. The eugenics court, however, refused to render such a decision because of tuberculosis; for, according to present-day medical knowledge, tuberculosis is not a disease that is always transmitted to offspring. In another instance the eugenics court refused a petition for the sterilization of a student of music, the reason assigned being that in this case (by exception) sterilization should not be performed because of the exceptional mental qualities of the patient, although, indeed, he presented a type of melancholy, or of manic-depressive insanity, which falls within the scope of the sterilization law. In all three instances of such a disorder in the student's family the precipitating cause took effect only on the appearance of external, nonhereditary factors. This was therefore a pathologic hereditary tendency of much less potency than the essential group of hereditary mental diseases, which develop of themselves without any external precipitating cause. Hence the court assumed that the offspring of this student, under normal living conditions, would probably escape an attack of the disorder. The court's second reason for its decision also establishes an important precedent: The petition involves an artist possessing unusual gifts, who is likely to transmit his gifts to his offspring. Likewise Professor Bonhoeffer, psychiatrist of Berlin, takes the attitude that the sterilization law should not be applied to persons of the type mentioned. In a family many members of which possess unusual qualities the chances of a descendant having serious hereditary defects may reasonably be risked by society if, on the other hand, valuable hereditary qualities are likely to be inherited. There are, to be sure, some jurists who object to this "exceptional treatment of persons with talents."

The question of "carriers" has also been up for discussion in Germany. Professor Fritz Lenz in an address before the Emperor William Society for the Advancement of Science favored the sterilization "of healthy persons who might produce offspring with hereditary defects." It is computed that this would affect twenty per cent of the population, which even in Nazi Germany is conceded to be rather a large undertaking.

The question of sterilization of those who are beneficiaries of government health insurance has been under consideration. Some two million "sickness cards" have been scrutinized. Of completed cases from this group 46.9 per cent have been considered as showing evidence of hereditary deficiency. In practice this has not resulted in a great amount of sterilization. Of the 2,220 cases investigated thus far and carried through the courts only 33 sterilizations have been performed. Many in this group are not reproductive prospects and sterilization would be useless.

These glimpses at various phases of the most extensive experiment in sterilization for human betterment suggest a commendable conservatism in administration, and a keen realization that in the long run "upon the management of the law its judgment by the people will rest."

ROBERT COOK.

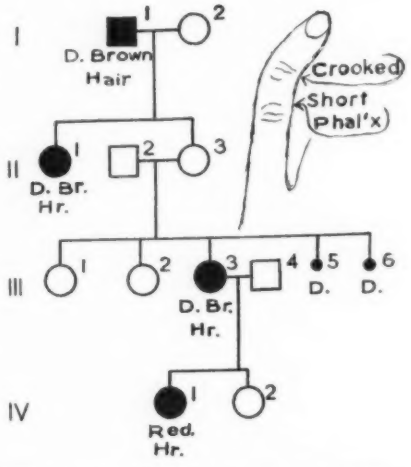
# THE INHERITANCE OF CROOKED LITTLE FINGERS

## No Apparent Linkage of Finger Defect and Hair Color, as Reported by Tomesku

TOMESKU* has described a family having bent little fingers similar to the ones described in this article. He thinks this condition is closely linked with black hair (brunette) as all sixteen cases contained in the family pedigree which he gave were brunettes with black hair, and he did not find the condition occurring with blond or brown hair. This is spoken of as a case of two dominant dissimilar traits being linked, and is interesting because it is supposedly a case of linkage other than sex linkage in humans.

The writers present two families which will be discussed in this connection.

In the individuals indicated in the family charted below, the third phalanx bends inward (radially) toward the fourth finger. In all cases the little finger only is affected, and the third phalanx is the only one bent. The second phalanx is shorter than the others which are of normal length. The joints themselves are flexible and otherwise normal. In each case the crooked little fingers occurred on both the left and right hands. The toes were normal in the III and IV generations, but the condition of the toes in generation I and II was unknown.




**FOUR GENERATIONS OF BENT LITTLE FINGERS**

**Figure 2**

Pedigree chart of a peculiarity of the little finger inherited for four generations. The affection skipped a generation indicating that it is not always dominant in inheritance. The bend is in the third phalanx and not in the joint. The second phalanx is shorter than normal.

An individual with crooked little fingers from another family showing this same anomaly was examined, but a reliable family history could not be obtained. The grandfather had crooked little fingers, then the trait skipped a generation (in certain cases at least) and showed up in several male and female grandchildren of different sibships. The individual examined in this family was blond, the hair being light brown.

Judging by the families presented in this paper it is not true that crooked little fingers do not occur in blonds, as IV, 1 is redheaded, and the individual examined in the second family discussed was a blond. The hair of the other individuals on the chart (I, 1; II, 1, and III, 3) is dark brown. These two traits, black hair and crooked little fingers, are not closely linked in this family; in fact, it may be questioned whether they are linked at all.

In both families presented in this paper this trait (crooked little fingers) skips a generation. In these families, therefore, the condition must be recessive, rather than dominant, unless more complicated genetical factors are involved.

LEROY C. GLASS and ELSIE MAGEE
*University of Idaho*

*TOMESKU, I. 1928. Kongenitale Deviationen der Phalangen. Angeborene Contracturen der Finger und Klinodaktylien. *Arch. f. Orthop. u. Unfall-Chir.*, 26: 126-137.

# INTERNAL STRUCTURE OF SALIVARY GLAND CHROMOSOMES IN SCIARA

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IN an earlier paper in this JOURNAL[11] on the salivary gland chromosomes of Sciara attention was given very briefly to two features which call for more detailed treatment. One concerns the structure of the chromatic segments or "discs"; the other, the differentiation of the achromatic materials in different regions of the chromosome. Since both of these features bear on the problem of the physical nature of the gene and of chromosome organization in general we have given them especial attention in our studies on Sciara. The present account deals with them somewhat in detail, and in the order just indicated.

## Structure of the Chromatic Segments or Discs

The chromatic segments, referred to by previous authors as "bands," "rings," "discs," etc., have been interpreted in various ways. Alverdes[1] considered them to be fragments (i. e., individual coils) of the original chromonema,* and hence essentially degeneration products. Most other investigators, however, regard them as "normal" structures, presumably related in some way to the chromioles ("ultimate chromomeres" of Belling[2]). The visible "granules" found in some of the bands have been interpreted by some authors† as representing individual genes or spaces between successive genes in "gene strings." On this view each chromosome (pair) is a cable made up of a definite number of spirally disposed longitudinal strands or chromonemata (gene strings) derived by repeated division of the original chromonemata and each "band" or "disc" is really a circle of granules derived by repeated division of the original granules (chromomeres) at that particular position in the chromonemata. This view considers each circle or band as made up of 4, 8 or 16 granules, according to the number of divisions undergone by the original granule, and considers the enormous size of the chromosome to be due to this internal multiplication of parts. It is supported by the visible evidence of granules, and of thread-like striations connecting them in linear series.

A third interpretation has been proposed by Metz and Gay[9,10] (see also Doyle and Metz,[5] and Metz[11]). This agrees with the interpretation just outlined in regarding the bands or discs as "normal" structures, not degeneration products; but it considers the striations and probably the granules to be artifacts due to distortion of the normal structures.‡ According to this view each band or disc is, so far as visible evidence is concerned, a unit of essentially homogeneous constitution. It would, therefore represent a single chromomere, unless the assumption is made that there is an inherent limit to the size of a chromomere (reflecting a limit to the size of a gene) and that the great size of the structures here could only come through internal multiplication. If the latter assumption is made, the present interpretation would lead to the view that so many internal divisions have taken place as to make the individual units invisible. As pointed out previ-

* See also Heitz,[6] Kaufmann.[7]

† See Koltzoff,[8] Bridges.[3,4] This view is also accepted by Muller and Prokofieva.[12]

‡The granules have been described (e.g., by Alverdes and by Koltzoff) in "living" material; but as noted by Doyle and Metz they apparently become visible only during degeneration or shrinkage and are not to be seen in the truly normal living condition.

ously[5] this would be a reasonable interpretation if the size of the chromosome were attributed to internal division, because the chromosome is at least hundreds of times, instead of only eight or sixteen times, its original size.

The interpretation of Metz and Gay, which will be developed further in the present account, is based on studies on Sciara, supplemented by observations on Drosophila. The evidence on which it rests, together with a more definite statement of the interpretation itself, will be outlined briefly at this point in order to facilitate the subsequent presentation of descriptive details.

**Summary of Previous Evidence**

1. The bands appear to be continuous discs extending entirely through the chromosome pair (if fusion is complete). 2. When granules are present in a band they appear likewise to form a plate extending entirely through the chromosome transversely. 3. Upon fixation the chromosomes may be seen to undergo great shrinkage and distortion[5]. 4. The coagulated achromatic material gives the appearance of a network or honeycomb which, when stretched or twisted, produces striations suggesting threads. 5. The granules bear a definite relation to the alveoli or vacuoles of the honeycomb, each granule lying at the junction of two or more alveoli. 6. The granules are usually irregular in form and elongate in the plane of the disc. 7. The number of granules in any one disc does not appear to be constant, even in comparable cells. 8. The degree and character of granulation varies with the fixing agents employed.[5]

**Outline of Present Interpretation**

Such observations have led us to the view that in the living chromosome the chromatic material is probably in the form of entire discs extending through the chromosome transversely, and that the formation of the visible granules is a result of distortion or perforation of the discs. This distortion is apparently due primarily to the interrelations or interactions of chromatic and achromatic materials during coagulation. The evidence indicates that a disc may be made to appear as a continuous band or a row of granules according to how it is fixed. With the ordinary aceto-carmine method (45% acetic acid) the alveoli or vacuoles in the achromatic material are conspicuous and apparently distort the chromatic discs strongly (see Figures 5*B*, 5*C*, 5*D*, 6*B* and 6*D* of preceding paper[11]). Granulation is prominent here and the granules tend to be large. Preliminary treatment with osmic acid before application of acetic acid gives a different type of result, characterized by a tendency toward smaller vacuoles and fine but extensive granulation (Figure 7*D* of the former paper[11] and Figure 5*C* and 5*E* of the present paper). Preliminary treatment with formalin, on the other hand, tends to result in inconspicuous vacuoles and a tendency toward smooth bands (discs) with relatively little granulation (see Figure 4*B*, 4*C*, 4*D*, and compare Figure 5*D* of the present paper with 6*D* of the preceding paper[11]).

As intimated above, the network or honeycomb in the achromatic material apparently represents the walls of, or spaces between, closely crowded vacuoles or alveoli which seem clearly to represent fixation products and not preformed structural elements in the chromosome. On the present interpretation the distortion due to coagulation with shrinkage, together perhaps with swelling of some elements, causes localized thickenings and indentations in the discs, determined by the positions of the vacuoles. As a result the bands may appear in the form of wavy or zig-zag lines or as rows of granules. Where the distortion results in actual or apparent perforations in a disc the latter shows a sieve-like structure which, when viewed edgewise in optical section, looks like a row of granules. Thus a disc with many small perforations would give the appearance of a band consisting of numerous small granules, while a thick disc (or fused discs such as described below) with a few large

perforations would give a band consisting of a few large granules.

It is evident that the problems under consideration here are difficult ones, for they involve the interpretation of delicate details of structure in material treated with reagents (especially acetic acid) which are known to distort protoplasmic structures, and which in the present case may readily be seen to produce distortion. Consequently it is believed that any interpretations at present should be tentative in nature, and that what is needed primarily is intensive comparative study of particularly favorable regions in individual chromosomes. A favorable region should be one in which the granules are large in size and small in number, and hence relatively easy to study. The present account is based largely on a study of such a region.

### Explanation of Terms

Throughout this account the terms "band" and "disc" will be used interchangeably and in a purely descriptive sense to represent the chromatic material at any one transverse plane in the chromosome. Likewise the terms "alveoli" and "vacuoles" will be used interchangeably and merely for descriptive purposes, without implying that they pre-exist in the living chromosome. The term chromosome will be applied to the entire structure, which is actually a pair of homologues fused together.

### Details of Structure

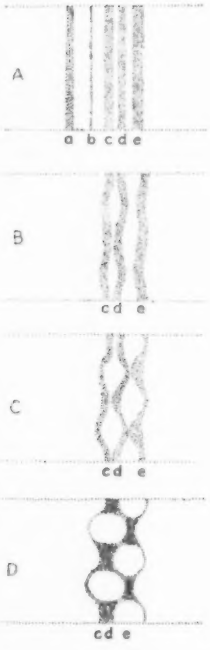
The region in question is near end 1 of chromosome *B* in *Sciara ocellaris* Comst. A short distance to the right of this region (away from the end) the chromosome is often greatly enlarged and internally disorganized, as shown in the accompanying Figures 5*B* and 5*C*, and in Frontispiece of the former paper[11]. In other cases, however, little or no enlargement is seen here, as indicated by the accompanying Figure 5*A* and by Figure 7*B* of the former paper[11].

In the region to be described the achromatic materials tend to produce large vacuoles when treated with acetic acid and consequently, on the present interpretation, large "granules" are found here, in contrast to the smaller ones found in most of the other regions showing granulation. Particular attention will be paid to the structures at the locations marked *c*, *d* and *e* in the accompanying illustrations of this region (Figures 3, 4, 5). Emphasis will be laid on the features enumerated above (p. 492) and also on evidence which indicates that certain apparently discrete granules are in reality made up of parts of two or more bands which in other preparations form separate rows of granules.

A description will be given first of conditions found in ordinary aceto-carmine, or osmic-aceto-carmine preparations, in which the "granules" are prominent. Then material will be described which is considered to represent more nearly the true organization. The account is based on a study of scores of specimens prepared in various ways, including those mentioned above.

A common appearance of the bands in question in aceto-carmine or osmic-aceto-carmine preparations is shown in the photographs in Figure 5*A* and is represented schematically in Figure 3*D*. The most characteristic feature in such preparations is the row of block-like "granules" at *c-d*. Close to this row, at the right, is a row of smaller "granules" (*e*) alternating in position with those of the former row. Frequently *e* appears as a continuous band. At the left of row *c-d*, toward the end of the chromosome, is a delicate band (*b*), often invisible; and somewhat beyond this is a prominent one (*a*).

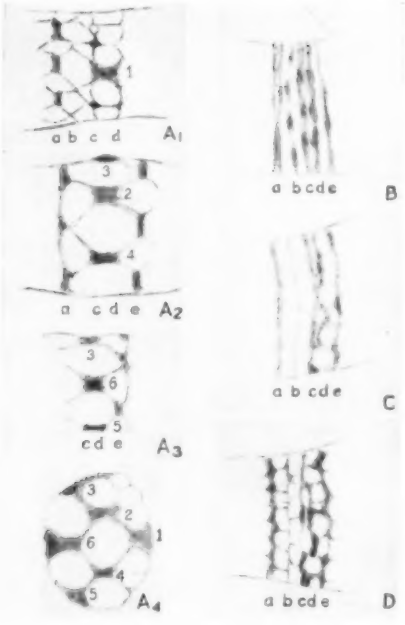
Additional illustrations of this type of condition are represented by the photographs in Figure 5*B* and in the drawings shown in Figure 4*A*. These represent characteristic conditions in preparations of this type, and will be considered in detail. The smear from which Figure 5*A* was made was accidentally damaged after the photographs were taken, so the details of this figure cannot be described. The two




**"GRANULES" FROM DISCS**

**Figure 3**

Diagrams illustrating in purely schematic fashion the manner in which the row of heavy "granules" at *c-d* is thought to arise through transformation during fixation of two original smooth discs. Coagulation and shrinkage (not represented in the diagram) produce large droplets or vacuoles between the discs and cause material from the discs to flow in between the droplets, forming block-like granules. *B* and *C* do not necessarily represent intermediate stages between *A* and *D*, but merely indicate the relationship between the respective structures.




**DETAILS OF CHROMOSOME STRUCTURE**

**Figure 4**

Free hand drawings of the region under consideration near end *1* of chromosome *B* in *Sciara ocellaris*. The letters *a, b, c, d, e,* indicate corresponding bands in all cases. *A-1* to *A-4* are from one individual chromosome (pair) in an osmic-aceto-carmine preparation. *A-1* to *A-3* represent respectively conditions seen at a high, an intermediate and a low focal level, showing the relation between the vacuoles and the granules, especially in the locality marked *c-d*. *A-4* represents a reconstruction of a cross section of the chromosome (pair) at *c-d*. The numbers indicate the identity of the granules in the figures.

*B, C* and *D* represent the same region as that shown in *A*, but from preparations fixed in formalin followed by acetic-acid, as explained in the text. Each is from a separate chromosome and represents only one focal level. These are considered to represent a more nearly normal condition, with less distortion, than that shown in *A*. For further explanation see text.

photographs of Figure 5*B* represent, respectively, a high and a low focal level in the same chromosome. They include all the "granules" visible in the *c-d* region. The middle "granule" in the first figure (5B-*1*) extends entirely through the chromosome vertically. In other words it is visible at the highest focal level, even above that shown, and may be followed down continuously to the lowest level. It is seen at a low focus in the second figure (5 B-*2*) (middle). It is not uniform in thickness and shape throughout, but appears to be continuous. The granule on the lower side at the higher level (Figure 5 B-*1*) is shorter, but may be seen

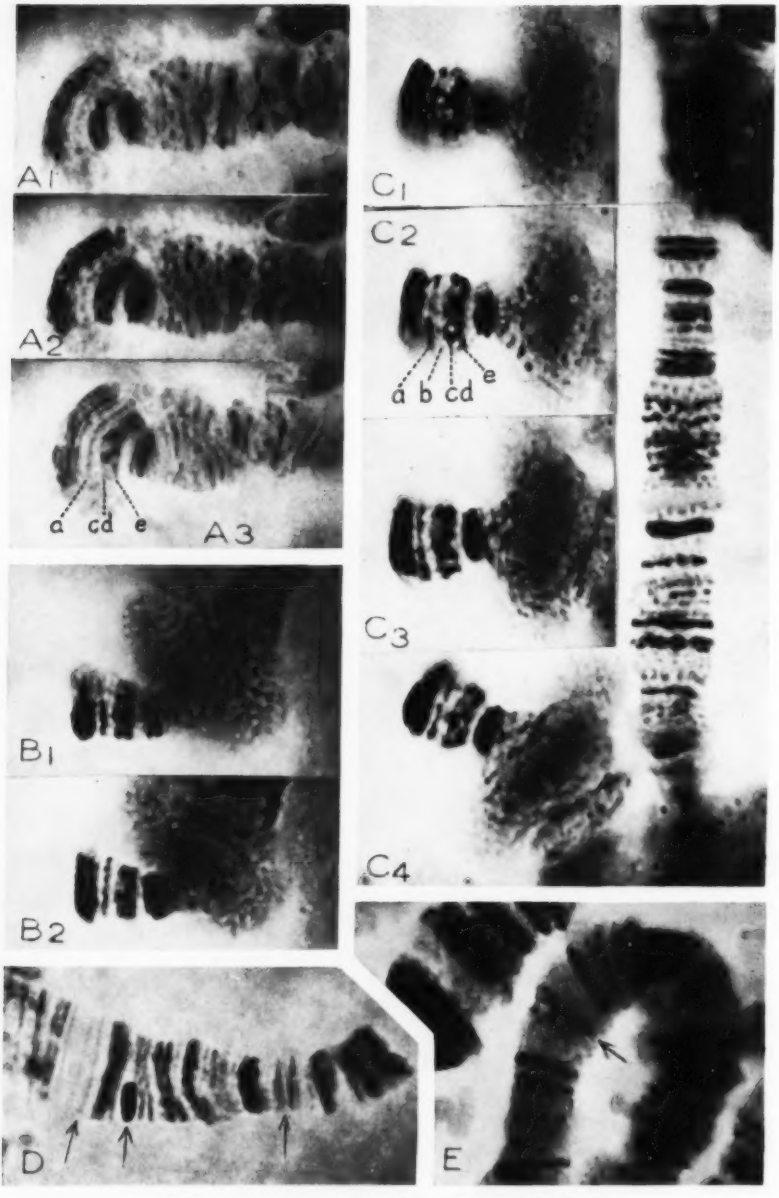
faintly at the lower level (*B-2*). The one on the upper side at the high level is also short and is only slightly connected with that in the corresponding position in the other figure. If the long middle granule is regarded as a single structure, the total number in the disc is four, with this one twice or three times the size of the others. If it is considered to represent two or three granules interconnected, the number is five or six in the entire cross section of the chromosome.

Before considering the other photographs, attention will be given to the case represented by the drawings of Figure 4*A*. These are free-hand drawings made by the writer from a fresh osmic-aceto-carmine smear. *A-1* represents the uppermost focal level of the region *c-d*. At this level one large "granule" is visible in this region. It is marked *1* in the drawing. On either side of this are outlines of "vacuoles," interconnected with those of other vacuoles in adjacent regions, as indicated in the figure. These outlines taken together form an irregular network. Three granules are seen in band *a* at this level, as indicated, but band *b* is so completely broken up as not to be recognizable. At a slightly higher level band *a* is continuous across the space above the three granules. Band *e* is out of focus at the level shown in the figure (*A-1*). Figure 4 *A-2* represents the next lower level at which additional granules are to be seen. In other words it is obtained by focussing down until the first granules at a lower level are in focus. No granules are omitted. Directly under granule *1* appears a large vacuole, and on either side of this a large granule (Numbers *2* and *4*). These bear the same relation to surrounding vacuoles as did Number *1*. At one margin is a third granule, (Number *3*). At this level, band *a* is practically continuous but not uniform in thickness. Band *b* is completely disorganized here; its material has apparently fused with that of *a* at the intersections of the vacuoles. Band *e* at this level is represented by three long "granules" bearing the same relation to vacuoles as those of *c-d*. The granules in *e* alternate in position with those in *c-d*, and it seems evident that this alternation is due to the position of the vacuoles. Each granule in *e* is at the apex of a large vacuole separating two granules of *c-d*.

Figure 4 *A-3* represents the next lower level at which different granules may be seen—and represents practically the lowest level of the chromosome. No further granules are seen below this, and none between it and the level represented in *A-2*. At this level granules *2* and *4* are out of focus, but *3* is still visible because it is relatively long and slender in a vertical direction. The two vacuoles seen at this level (in region *c-d*) are directly below granules *2* and *4*, respectively. Granule *5* is small and lies below the vacuole seen at the lower side in *A-2*. In band *e* at this level two conspicuous granules are visible at the apices of the two large vacuoles just mentioned. A third granule is to be seen at the upper side which probably represents a continuation of the one at the corresponding position in *A-2*.

As indicated in the figures just discussed it seems clear that the system of vacuoles forms an irregular honeycomb structure at all levels in the chromosome here, and that the granules bear a definite relation to the vacuoles in any longitudinal plane. Since the granules at *c-d* are known (see below) to be made up of material from at least two distinct "bands" (*c* and *d*) it seems clear that their position and shape is due to the vacuoles. Likewise their number (six) appears to be determined in the same manner.

Figure 4*A-4* represents a schematic reconstruction of a vertical plane across the chromosome at *c-d*, made from observation of the various levels under the microscope. It is believed that this figure is reasonably accurate so far as the essential structures are concerned. The reconstruction illustrates the fact, readily seen by focussing the microscope, that in a transverse section of




**FOCUSING THROUGH THE CHROMOSOMES**

**Figure 5**

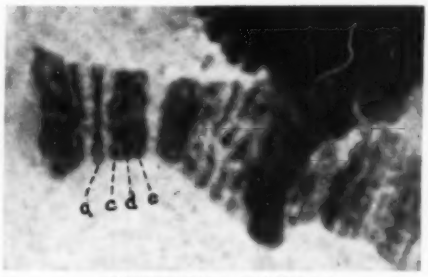
Photographs of selected regions in salivary gland chromosomes of *Sciara*. All but *E* are from *S. ocellaris*. *E* is from *S. coprophila* Lint. (A reading glass may aid in the examination of these figures.)

*A*, *B* and *C* represent the region under special consideration near end *1* of chromosome *B* in three individual chromosomes, fixed by the osmic-aceto-carmine method. *B* and *C* are from one pair of glands in one preparation. *A-1* to *A-3* represent respectively high, intermediate and

(*Continued on page* 497)

the chromosome the "granules" bear essentially the same relation to the vacuoles as they do in longitudinal section, except in so far as the picture is influenced by the fact that originally the chromatic materials were confined to distinct transverse "discs" or planes. As indicated by the reconstruction, the granules all tend to be interconnected by chromatic material extending between the vacuoles. In the case of granules *1*, *2* and *3*, if the connections were a little thicker and the disc were viewed from the right angle, edgewise, the three would look like one long continuous structure such as the middle granule in Figure 5*B* appears to be.

The photographs shown in Figure 5*C* illustrate a different condition, although they are from material prepared in the same manner as that just considered (Figures 4*A*, 5*A*, and 5*B*). Indeed Figures 5*B* and 5*C* are from the same preparation. The difference appears to be due to the fact that in the chromosome shown in Figure 5*C* the vacuoles in the region *c-d* are more numerous and more irregular, with the result that numerous granules of various sizes appear and that these are interconnected in such a manner as to prevent making an accurate count.




**NUMEROUS ALVEOLI**

**Figure 6**

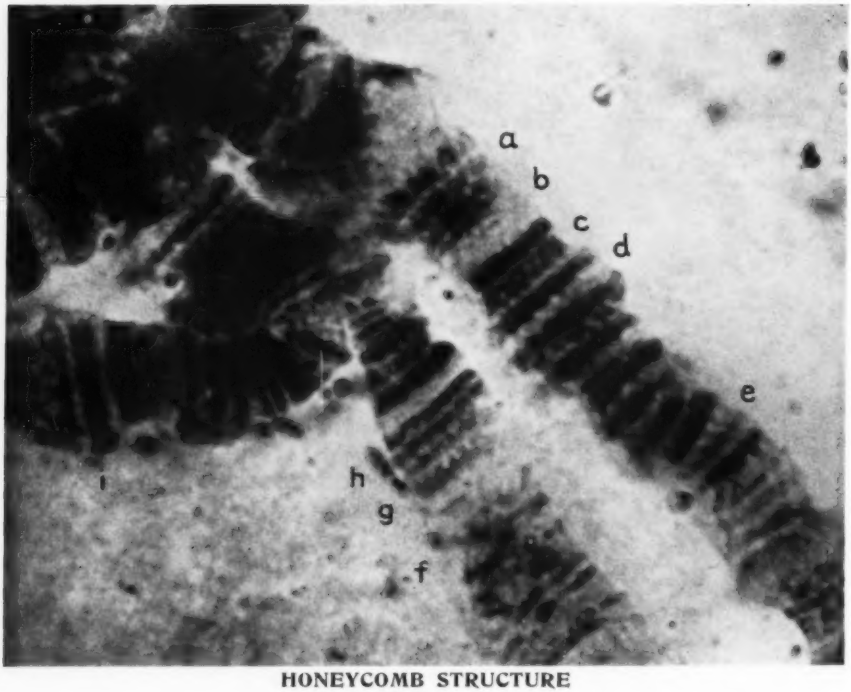
Photograph from an aceto-carmine preparation illustrating a condition similar to that shown in diagram *C* of Figure 3, except that the vacuoles and granules are more numerous. Some of the chromatic material of bands *c* and *d* has flown in between the vacuoles separating these bands, indicating how the block-like granules are formed. (2666 ×).

Another type of condition is represented in Figures 4*B*, 4*C*, and 4*D* drawn from material (smears) fixed in formalin, followed by acetic acid (45%) and stained in crystal violet. There appears to be considerably less distortion of the chromosome structure in material prepared in this manner. Often bands *a*, *b*, *c*, *d* and *e* may all be identified individually, as indicated by Figures 4*B* and 4*C*. The material is difficult to photograph, however, because the cells do not flatten out readily after formalin treatment and stained cytoplasm usually lies above and below the chromosome. In the preparation from which the former figure was made, the vacuoles are relatively small and inconspicuous, and their outlines cannot be seen clearly. This preparation shows distinctly that *c* and *d* are separate bands and also that *a* is compound. As intimated above, it seems probable that not only *a*, but *c*, *d* and *e* are each made up of two or more bands.

*Legend to Figure* 5—Continued

low focal levels in one chromosome. Similarly the two photographs in *B* and the four in *C* represent series of focal levels, beginning in each case at the top. In *C-4* a longer, somewhat stretched region of the same chromosome is also included. Details are described in the text.

*D* is a photograph of end *2* of chromosome *A*, from a formalin-acetic-crystal-violet preparation, for comparison with the corresponding region shown in figure 6-*D* of the preceding paper in this JOURNAL.[11] The latter figure 6-*D* is from an aceto-carmine preparation, showing the typical granular appearance of the bands. Some individual rows of granules in this are seen as pairs of smooth or finely granular bands in the formalin preparation shown in the accompanying figure (e.g., near the arrow at right). Other regions of interest for comparison are indicated by the other arrows. The middle arrow indicates the region showing a deficiency in one member of the pair—also indicated by an arrow in the earlier figure. *E* represents selected regions from an osmic-aceto-carmine preparation showing details of internal structure which are discussed in the text. The region indicated by the arrow shows a type of structure similar to that shown in Figures 3 and 4 and at *c d e* in *A-C* of this figure. Adjacent to this and in other regions are distinctly different types of structure, with smaller sizes of vacuoles and correspondingly smaller meshes in the network or honeycomb and smaller and more numerous granules in the bands. (1733 ×).




**HONEYCOMB STRUCTURE**

**Figure 7**

Portion of a chromosome group of *Sciara coprophila* from an iron-aceto-carmine preparation, to show details of chromosome structure. Regions of special interest are indicated by letters. The network, or honeycomb structure is prominent in several regions, one indicated by *b*. Stretching has given this the form of striations extending diagonally in both directions from *b* to *a*. Similar striations are seen in the region marked *e* where the chromosome has been indented. Note that the striations follow the direction of stress in the chromosome. This is shown also at *f*, where the chromosome has been distorted and stretched in a diagonal direction. The zig-zag structures discussed in the text of the previous paper are seen at various regions, including those marked *c* and *g*. The relation of the "alveoli" or "vacuoles" to the "granules" in the chromatic segments is seen at *b*, *d* and *i*. (2900 ×).

In Figures 4*C* and 4*D* conditions are shown which apparently represent a somewhat greater degree of distortion of the structures, and which tend more to resemble those found in ordinary aceto-carmine or osmic-aceto-carmine preparations. In the former figure all five bands are seen, but *c* and *d* coalesce in some parts. The relation of the vacuoles to the thickenings or "granules" is evident. It is to be noted that bands *a*, *b* and *e* are each continuous and show relatively little sign of granulation. In the other figure (4*D*) the bands tend to be broken into segments or granules. The relation of these to the vacuoles is seen conspicuously here.

In summarizing and interpreting the observations just outlined the following features may be emphasized:

1. The fact that the two bands *c* and *d* described here may appear as separate rows of granules or may coalesce to form one row of larger granules makes it seem certain that the latter granules do not represent discrete, pre-existent structural units in the chromosomes. They are apparently due directly to the artificial treatment employed.

2. If this is true of large conspicuous

**"THREADS" OR "STRESS-LINES"?**
**Figure 8**

Portion of a chromosome group of *Sciara coprophila*, from the same preparation as that shown in Figure 5*E*. The striations in the chromosome at the right in this photograph look superficially like threads, but careful comparative study indicates that they are artifacts produced by partial disorganiation of the chromosome through stretching and local distortion. The fixed chromosome has apparently been broken open and indented on the left side causing the striations to curve in the shape of a bow. They extend linearly, instead of in spirals, and otherwise resemble the lines of stress found in numerous other cases of stretched chromosomes. Intermediate conditions illustrating the derivation of these thread-like structures from the network or honeycomb will be shown in another paper. (1950 ×).

granules it seems reasonable to suspect that smaller granules may likewise be due to artificial treatment. The alternative, of course, would be the assumption that small granules exist in the living condition and either fail to separate or are artificially fused in clumps by fixation. Neither of these alternatives, however, appears to account for the other phenomena under consideration.

3. When large granules are visible at *c-d* they may appear at first sight to be homogeneous, distinct, fairly uniformly spaced, and definite in number. Close examination shows, however, that they are not necessarily homogeneous, that they vary materially in size and shape, are often interconnected and irregularly spaced, and that the number is often a matter of interpretation. Furthermore, in comparing the numbers in different cells, even in the same preparation and where the chromosomes appear to be essentially the same size, it has been found that the number varies widely. In some cases there seem to be not more than three or four in the entire disc at *c-d*, including all focal levels, while in others the numbers appear to range up to ten or more.

4. Although the region under consideration exhibits wide variations in appears in different preparations it shows a tendency toward the production of unusually large "vacuoles" in the achromatic material, which distinguishes it from most other regions. This is considered to reflect corresponding protoplastmic differences.

5. The walls of the alveoli or vacuoles, distinctly visible in many preparations, interconnect in such a way as to form a coarse network or honeycomb structure in the region under consideration. The coarseness of this network contrasts with the more delicate, smaller meshed structure of the network found in regions exhibiting small granules. The network is visible at all levels through the chromosome transversely.

The type of condition found in the more "ordinary" regions of the chromosomes is illustrated in the photographs shown in Figures 5 *C-4* and 5 *E* which are taken from fresh smears made by the osmic-aceto-carmine method. The granules and the vacuoles or alveoli are

nearly all smaller here, but their interrelations are essentially the same as those found in the grosser structures described above. Special regions of interest in these photographs are described in the legends of the figures and in the next section of the paper.

### Evidence of Linear Protoplasmic Differentiation in the Chromosome

In addition to the linear differentiation represented by the sequence of chromatic bands in the salivary chromosome it has been found that the *achromatic* materials in different regions show different types of structure in fixed preparations. This latter type of differentiation is considered to have particular interest because of the probability that it reflects a corresponding qualitative (chemical) differentiation of the protoplasm which may in turn reflect differences in the genes. The chromatic bands give a conspicuous morphological differentiation, but so far as our evidence goes they show no visible signs of qualitative differentiation. No attempt will be made here to determine the relative importance of chromatic and achromatic materials. It seems probable, as indicated in the preceding paper,[11] that both categories are essential; but present attention will be confined primarily to the achromatic constituents.

As already noted, the differences in the achromatic materials are differences in relative coarseness or fineness of the network or honey-comb, which in turn reflects differences in the size of the vacuoles or alveoli. Although each region may vary in these respects in different preparations, it nevertheless appears to possess distinct characteristics. The material between bands *c* and *d* described in the preceding section, for example, is characterized by a tendency to form relatively large vacuoles. In this case the adjacent regions also tend to form relatively large vacuoles, although apparently not as large as these. In other parts of this chromosome, however, distinctly finer types of structure are found, as shown at the right in Figure 5*C-4*.

In some cases abrupt changes may be seen in the type of structure. An example of this is shown in Figure 5*E*. At the point marked by the arrow in this figure is a region characterized by large granules and large vacuoles, somewhat like that described above. Immediately to the right of this region, however, the structure changes abruptly to one characterized by numerous delicate granules and small vacuoles, making a delicate network or honeycomb*. Several finely granular bands are visible in the pale region here, and differences may even be detected in the delicacy of structure in the achromatic material between these successive bands.

To the left of the region marked by the arrow somewhat similar, but less delicate, structures are visible; and directly opposite, in the chromosome at the left of this one, are examples of still different degrees of fineness in the network and the granulation.

Similar characteristics, and even additional types of structure, are found in other regions and in other chromosomes, as may be seen by examination of the accompanying photographs and those of the preceding paper in this JOURNAL[11]. So far as we have been able to observe, the coarseness or fineness of the network is not dependent on the thickness or proximity of the chromatic discs. It seems reasonable to assume, therefore, that the differences are an indication of qualitative chemical differences in the living material.

Our observations also tend to indicate, as noted above, that these characteristics of the achromatic material are largely responsible for the characteristics of the discs (except thickness) as seen in fixed preparations. Individual examples of wavy and zig-zag bands, as well as several different types of granulation have been studied in some detail, and, although these studies are not all complete, the evidence obtained is consistent with the view that their charac-

*Examination of the figure may be facilitated by the use of a reading glass.

teristics, like those of the structures described in the present paper, are due largely to the mode of coagulation or vacuolization of the adjacent achromatic materials.

The longitudinal striations, interpreted by some observers as representing chromonemata, have been treated briefly in earlier papers and will be considered more in detail in a later one. A conspicuous example of such structures is shown in Figure 8. Although they bear a striking superficial resemblance to threads, careful comparative study indicates that they are artifacts and have no counterpart in the living chromosome.

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# THE GENETICS OF GARDEN PLANTS

THIS is not a controversial, theoretical, philosophical volume* calculated to whet the intellect. It has an earthy odor, which ought to recommend it to the honest-to-goodness intelligent dirt gardener, as well as to other types of humanity, interested in the improvement of the products from flower and vegetable gardening, orcharding, and general fruit-raising.

Essentially, it is an interestingly, authoritatively, but simply written treatise showing how the principles and facts unearthed by modern genetics and cytology apply to practical plant breeding and horticultural practice. Though not written in the so-called popular or semi-popular style, its material is set forth so as to present an opportunity to the informally trained individual interested in horticultural subjects to familiarize himself or herself with some of the current viewpoints.

There is an excellent glossary; the definitions being short and to the point ("students" will be very appreciative). "Gametes" and "pollen grains" are hardly synonymous. This, however, is only a quibble. I wonder how many geneticists would define a gene as "the hypothetical unit of reproduction and variation in the hereditary material" (p. 214)? Experimentally, at least, the gene is as non-hypothetical as a chromosome.

The last chapter describes and summarizes the part played by different genetic phenomena in originating new and improved forms of cultivated plants.

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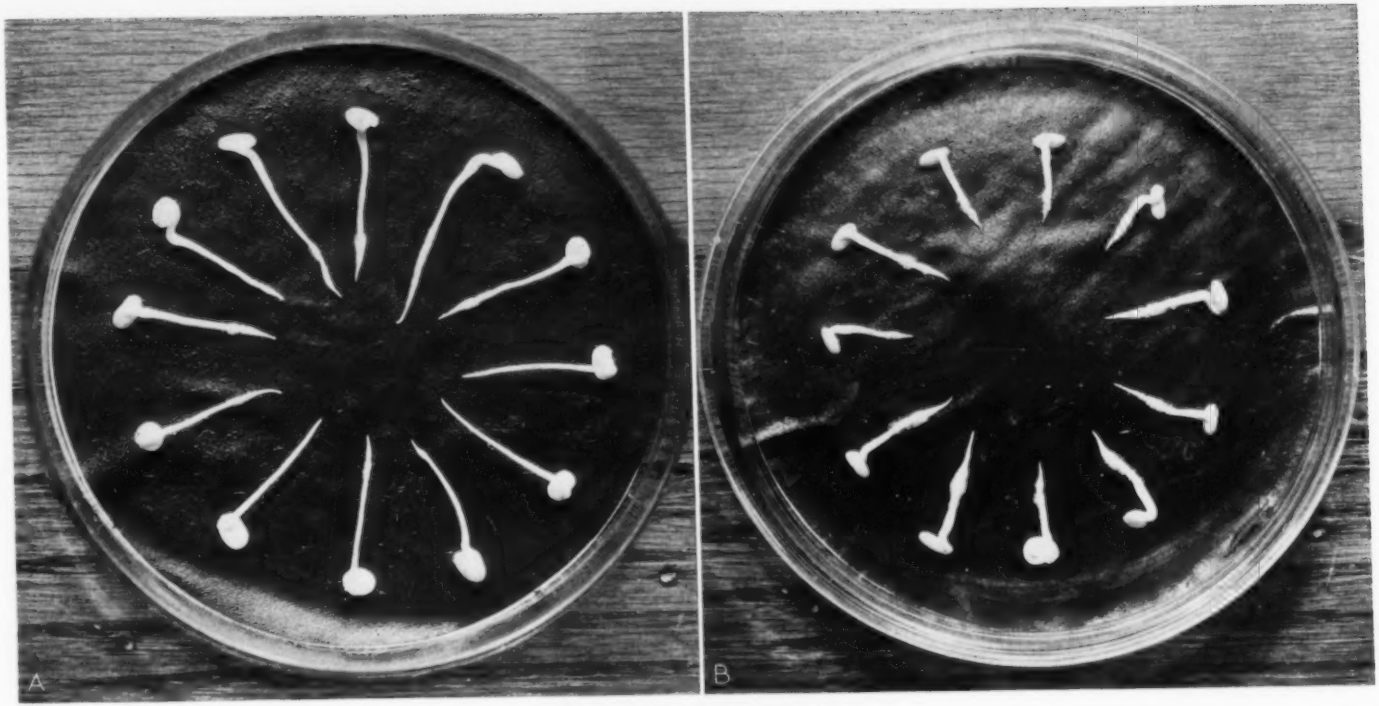
*Crane, M. B., and W. J. C. Lawrence (with a foreword by Sir Daniel Hall), The Genetics of Garden Plants. Pp. XVI and 236. 1934. Price 10/6. Macmillan Co. Ltd. London.




**TWO TYPES OF ROOTLETS**

**Figure 9**

Lupine seedlings, used for certain toxological tests yield on preliminary genetic analysis two types of rootlets, hairless (*A*) and hairy (*B*). The long hairless type is dominant over the short hairy form. The tests in which these rootlets are used depends on the rate of rootlet growth in 24 hours. The existence of genetic variations of this magnitude in the test material emphasizes again the great importance of genetically uniform material with which to make biological assays.

# TWO GENETICALLY DIFFERENT ROOTLET TYPES IN THE LUPINE

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DURING the past ten years, Macht and Pels[1] have developed a technique for testing the toxicity of blood sera of patients suffering from certain dermatoses, such as pemphigus vulgaris, or from other diseases such as pernicious anemia. As their basic test plant, they use seedlings of *Lupinus albus,* Hartwegii. When the seedling rootlets attain a length of about 20 mm, they are measured and are immersed in Shive's plant nutrient solution[2] to which a small percentage (1% to 5%) of blood serum has been added. After 24 hours the rootlets are again measured. The average amount of rootlet growth during this immersion is compared with the amount of growth obtained in plant nutrient solution alone. The percentage derived from this comparison is called the phytotoxic index.

Seeds secured from a local seed store for use in this test, when germinated on moistened filter paper in sterile Petri dishes, always presented two types of rootlets. A long, slender rootlet with no root hairs until after it reaches a length of about 30 mm was the most frequent type (Figure 9*A*). The less frequent type was much shorter and thicker by contrast and the root hairs originated almost simultaneously with the elongation of the root, beginning to arise almost at the point of origin of the root (Figure 9*B*). It was thought possible that these two types of rootlets might have a fairly simple genetic relationship. If a strain of plants could be selected which germinated and developed their rootlets uniformly, the validity of the phytopharmacological test would be enhanced, since the greater the uniformity in growth potential, the more reliable becomes the average based upon subsequent growth.

Four seedlings of each type were potted and grown to maturity. The seeds derived from the self fertilization of these plants were collected and sprouted. As will be seen in Table I, the plants from seedlings with short, thickened rootlets, well covered with root hairs (called hairy for this reason), produced seeds which, when germinated, gave rise to hairy seedlings again. The other plants produced seeds which were of two kinds—some sprouted as hairy seedlings and some as non-hairy. The ratio is approximately a 2:1; this may be because the homozygous non-hairy is lethal, or it may be due to other factors. The four-non-hairy plants tested were apparently heterozygous.

It is interesting to note in this connection that the hairy rootlets do definitely grow much more slowly than the other type. The 252 hairy seedlings grew an average of 4.11 mm during

**TABLE I. Results Obtained from the Seedling Counts**

| Plants Tested | No. Seeds Produced | No. Seeds Germinated | No. Sprouted as non-hairy | No. Sprouted as hairy | Rate of Growth in 24 hrs. |
|---|---|---|---|---|---|
| Normal 4 | 376 | 351 | 231 | 120 | 6.79 mm. |
| Hairy 4 | 370 | 252 | — | 252 | 4.11 mm. |

* The writer wishes to acknowledge his indebtedness to Mr. Ralph E. Griswald for his co-operation in providing space in Phipps Conservatory for the growth of the plants, and also wishes to thank Mr. Frank Sipper for his help in caring for the plants.

24 hours in Petri dishes, while the 351 seedlings (231 non-hairy—120 hairy) from the heterozygous plants grew an average amount of 6.79 mm under the same conditions.

### Discussion

Preliminary data now available show definitely that there are at least two genetically different rootlet types in *Lupinus albus*. Also the two differ markedly in the rate of rootlet elongation in young seedlings. This evidence is further proof of the fact that in experiments based on plant or animal reactions, extreme care must be observed in selecting material. It should be as homozygous as possible to eliminate as many as possible of the factors of genetic variation.

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## A YEAR BOOK FOR BOTANISTS

THE first volume of a new publication has recently appeared* which proposes to survey each year the progress of plant science in all parts of the world. Volume I is divided into six major portions: an almanac, an advance program of the Sixth International Botanical Congress (held at Amsterdam, September 2-7, 1935), and a history of earlier Botanical Congresses; a list of international and important congresses, committees and societies; a review of all branches of plant science through 1934; correspondence; new periodicals; new and changed addresses. Following this is a supplement containing an illustrated history of botany in the Netherlands, advertisements, and a general index of plant names and of persons.

The fourth section, reviewing all branches of plant science, is a detailed list of botanical organizations throughout the world. This contains an annotated list of personnel of institutions and statements regarding research in progress at each of them. The arrangement of this list is alphabetically by towns in which the various institutions are located. Thus the Department of Botany of Oregon State Agricultural College appears under "C" because it happens to be located at Corvallis, Oregon. If this post office address slips from mind, and if the name of a member of the botanical staff is not available to enable the index of persons to apply, the only way of locating the institution is to "thumb for it." A rearrangement of American entries under states would appear to be a highly desirable change in later editions, as it is impossible with the present arrangement to form any conception of botanical activities in a particular region, when related activities may be separated by as many as 20 pages.

There is no way to obtain references to any given subject by use of the index. Thus plant genetics occupies an important place in the activity in many botanical institutions; it is not possible, however, to review research in this field by reference to the index. Again one must pretty thoroughly read the book to find out what the genes of maize, antirrhinum, pisum, etc., are doing throughout the world.

In spite of these difficulties the volume contains much information that a majority of botanists will find extremely useful. Certainly every botanical library, whether devoted mainly to research, reference, or education, will find the publication invaluable.

**Chronica Botanica.* Volume I. Pp. 437. Fl. holl. 15. Editor, Fr. Verdoorn. P. O. Box 8, Leiden, Netherlands. 1935

# THE TREK OF THE GOLDEN FLEECE

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(*Concluded from the November Issue*)

### Austria, 1771

MARIA THERESA had noted the great success attained by the Merino breeders in Saxony, and in 1771 she imported sheep which some authorities say were Paduan silk sheep, the extremely soft fleeced Italian sheep descended from Spanish stock. Others claim they were from Saxony.[18] It seems probable that the first importation was from Padua, while shortly afterwards, in 1786, some Electoral sheep were brought in from Saxony. These sheep were established at the Government farm at Meropail in Hungary.[5,23] They thrived and became quite famous and afterwards were freely drawn upon in the rebreeding of the Electoral and Silesian flocks. They were spoken of as the robust Austrian Negretti type. Today the flocks of Austria and Hungary are primarily Merino in character.[17]

### France, 1786

It is quite likely that at a very early date Spanish sheep were taken across the southern border of France. A number of local French types are Merino in character and probably came from the same foundation.[23]

The unfortunate, licentious King Louis XVI of France made a great many mistakes. The sheep industry of the world, however, has him to thank for one very wise and fortunate act. In 1783 he bought the Rambouillet estate and established there an experimental farm for the acclimatization of animals and plants. Later, upon the advice of his scientific experts, Daubenton and Tessier, he commissioned M. Gilbert to select some choice Merino sheep from the finest flocks of Spain. These were purchased with the permission of the King of Spain. The first importation of Spanish Merinos to Rambouillet took place in 1786 and consisted of a flock of 383 sheep: 334 ewes, 42 rams, and 7 wethers.[1] These sheep did so well that M. Gilbert was commissioned in 1799 to make another trip to Spain and obtain some more of these sheep. He stated that he could not find any sheep there that would compare with the original sheep at Rambouillet. Spain had been at war since the purchase made in 1786, so that her flocks had been neglected and had degenerated. However, M. Gilbert, after considerable difficulty and with some hard won cooperation from the French monarch (which many say cost the life of this splendid sheep breeder), obtained 237 sheep, which were shipped to Rambouillet. Of this flock 46 ewes and 6 lambs were kept at Rambouillet, while the rest were distributed throughout France. This was the second and last consignment of Spanish Merinos to Rambouillet. Other importations of Spanish Merinos to France were made in 1796 and 1797 to private breeders.

Through the Treaty of Basel in 1796, France was to receive 100 rams and 1000 ewes from Spain annually for five years. The Spanish government, however, soon recalled this concession, so that only 2,000 ewes and rams were imported. Napoleon, who was at the height of his power at this time, did not take kindly to this action and proceeded to bring in as many Merinos as he desired. Rumor has it that he brought in fully 20,000 Merinos instead of the 5,500 stipulated in the Treaty.[15]

The French were always very much interested in the mutton qualities of their sheep, and from the first insisted on this quality in the sheep at Ram-

bouillet. They also kept careful records of the fleece and body weights of the entire flock. In 1794, 99 rams averaged 7 pounds 8 ounces of wool and the ewes sheared 7 pounds 1 ounce. In 1885, after 91 years of breeding at Rambouillet, 80 rams averaged 17 pounds 1 ounce, a gain of 9 pounds 9 ounces or 127 per cent; while 500 ewes averaged 11 pounds 5 ounces, a gain of 4 pounds 4 ounces or 60 per cent.[15]

M. Gilbert, who purchased the first Spanish Merinos brought to Rambouillet, gives the following description of these sheep:[1]

> The height of these sheep were from 24 to 30 inches—24 where the pasture was light, soil dry and feed poor. The highest type of rams had eyes extremely lively and quick movements. Their pace was free and rhythmical, and their heads wide, flat and square. The lines of their front, instead of being arched and short as in the French races, were straight, round on both sides and very large. Their ears were very short, the horns very thick, large, full of wrinkles and turned in redoubled spirals. The nape was wide and thick, the neck short, the crops round, the back well-rounded, the loins wide, and the dewlap hung very low and wide. The stern was wide and round. Body well covered with very fine, well crimped wool, superior to all races. It was even over all parts of the body from eyes to hoofs. It was remarkably free from yolk, but with sufficient oil to promote the greatest growth, and the finest fiber and most compact fleece, which always parted as a book opens. The finest ewes approximate in form and character the beauty of the finest rams.

From the large increase in fleece weight, it would appear that new blood had been introduced into the flock at Rambouillet. This, however, was not the case. The blood of the Rambouillet flock had been kept pure since the arrival of the Spanish Merinos, which were confined in the Grand Park at Rambouillet, completely surrounded by walls. W. C. Clos, who probably knows more Rambouillet history than any other living man, informed the writer that while at Rambouillet in 1900 he was shown a sample of Rambouillet wool about a hundred years old which was taken from a Rambouillet sheep confined in the Park. This sample was yellowed with age but showed remarkably good type. Those in charge at Rambouillet were able by very rigid selection to combine size, density of fleece, and increased length of staple without any loss of either strength or fineness.

### *English Influence*

Bernadine (cited by the *American Rambouillet Record*[1]) states that the introduction of the English mutton breeds into France caused the breeders of Merinos to desire a sheep with a larger and more symmetrical body form. They sought to attain this ideal in the sheep at Rambouillet by selection and high feeding. In 1802 the average ewe weighed, shorn, 80 pounds, while 45 years later in 1847 the average weight of the ewes was 120 pounds, an increase of 40 pounds. During the same time the fleece weight increased only one ounce, from 7 pounds 9 ounces to 7 pounds 10 ounces. At this time they discovered that the ewes were losing in fertility and thought at first that it was due to intensive inbreeding. Around 17 per cent of the flock were sterile. They noticed, however, that excessive fattening and poor fertility were closely associated and decided that excessive feeding and not close inbreeding was responsible for this decrease in fertility. In 1881 the sheep had returned to normal productivity due to moderate feeding and selection for better wool quality rather than for extreme mutton size and conformation. Some of the exceptionally fine sheep attained remarkable perfection in combining fineness and quality of fleece with mutton conformation.

### *Other French Merinos*

There were a number of other flocks of Merinos in France besides those at Rambouillet. The most important of these, which also obtained Spanish sheep from the first importation in 1786, were the flocks at Wideville (Gilbert's) and Issy. The Government established some 60 stud farms through-

out the country for the purpose of breeding Merino sheep, but the Government farm at Rambouillet was the only one which attained a decided success.[5]

*The Metis Merino*

There was another group of breeders, who bred what is called the Metis Merino, a half-blood sired by Merino rams out of native ewes. Such breeders as Lefebre, Escobille, Soreau-Machery, and Bailleau aine Illiers bred the Metis Merino and admitted that their sheep were crossbreds descended from a native ewe-foundation. Bohm (cited by Spoettel-Taenzer[18]) states that the Metis Merino was remarkably true to type and was a valuable breeding animal, even surpassing the purebreds at Rambouillet in body size and weight. Wing[22] speaks of a visit to Cherville, the farm village of the Thirouin-Soreaus. This flock has been owned by the same family since 1785 and is one of the oldest of the so-called Rambouillet type in France. So one of the Rambouillet flocks founded on the Metis Merino was thriving in 1911 and no doubt is in existence today. The name Rambouillet was gradually applied to all French Merino sheep of combing wool type regardless of their origin.

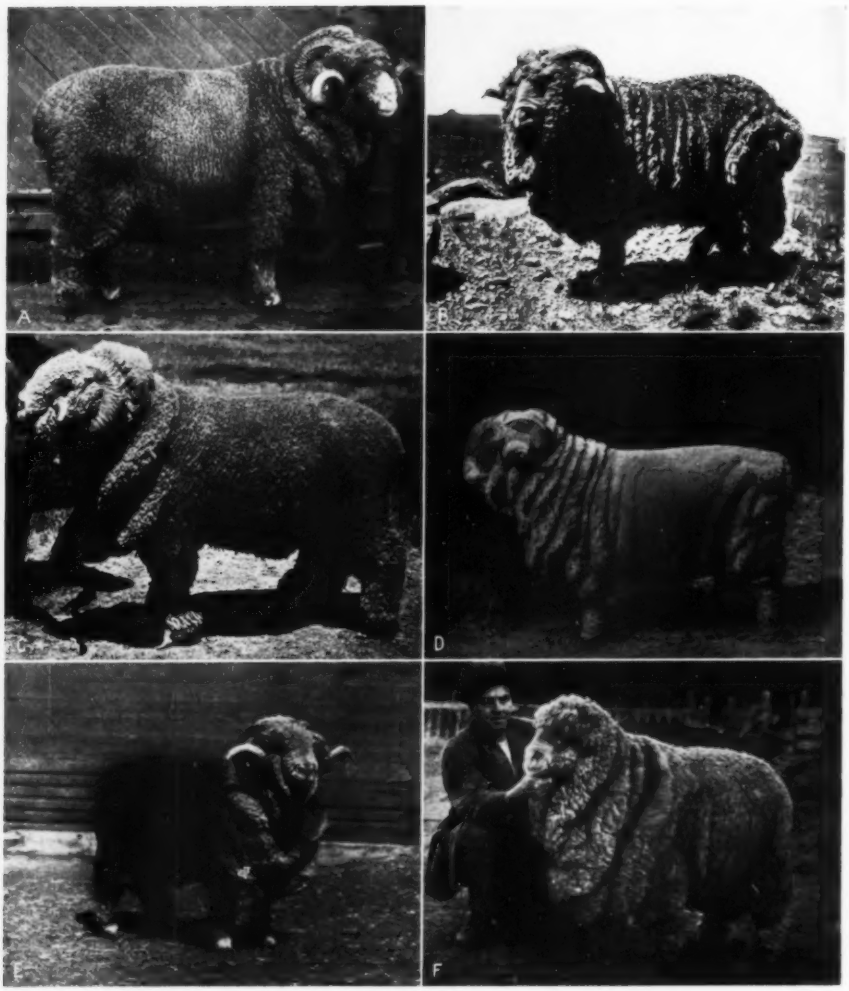
*Mutton Merinos in France*

Spoettel and Taenzer[18] give a fine description of the various types of French Merinos outside of the Rambouillet flock. The Soreau-Thirouin flock which has already been mentioned, is one of the most popular types in France next to the Rambouillet. This flock showed the Negretti type and hence was very popular in Germany. The flocks of Lefevre and Escobille were easily fattened but lacked substance of fiber and showed defects in the belly wool. The most perfect mutton forms and greatest weights of the French types were shown by the flocks of the District of Brie, particularly in the animals of the Ile-de-France (Dishley Merino). Their thriftiness, early maturity, and feeding economy were greater than that of the Rambouillet flock. Some of the best Mutton Merino flocks in Germany have used and still are using Ile-de-Franc rams. The Soisonnais, a large robust Merino of northern France, was in demand in Germany, as was also the Chatillonnais type, which was slightly smaller but outstanding for its early maturity and feeding economy. Another French type, the Berrichoune, has been quite popular in later years among the German Mutton Merino flocks. This type retains the early maturity and feeding economy of the other French types, and according to Mr. Thilo is also superior in fertility. (See also Heinicher[11]).

Pictures of the Ile de France sheep taken at the livestock exhibitions show them to have excellent conformation as well as a desirable type of wool. The French have a unique system of fitting for show, in that the sheep are shorn down to the skin except for one spot on the shoulder where a tuft of wool is left. Thus the judges are able to see the body conformation quite plainly and at the same time have available a tuft of wool which is sufficiently large to show the fleece character.

**Australia, 1794**

When Australia was first settled it was regarded as a place suitable only for convict farms where desperate criminals could be isolated with little hope of escape. Little thought was given to its natural herbage, and what attention was given to it described it as insufficient to nourish animals in any numbers. However, Captain MacArthur, an army officer who received, as did the other officers, a grant of one hundred acres of land at Paramatta,[20] was a good agriculturist. He was the first man in the colony to cultivate land, and among the original livestock on his farm were some of the Bengal type of sheep from India, a rather coarse and hairy type of sheep used for meat. He was quick to notice the improvement in the natural fleece covering of these sheep when kept




**MERINOS OF THE EARLY TWENTIETH CENTURY**

**Figure 10**

*A*—Von Homeyer type of Rambouillet ram bred by A. A. Wood and Son, Saline, Michigan, in 1901. *B*—"McKinley," Vermond Merino ram bred by King and Shattuck. His dam was Lady Burwell, holder for the record for fleece weight, and his sire was Champe, champion Merino ram at the Chicago Exposition in 1893. Photographed in 1895. *C*—"Beaconsfield," bred by Thomas Wycoff of Michigan, and foundation sire of King brother's flock at Laramie, Wyoming. *D*—Ohio Premier Rambouillet ram bred by Orth and typical of the Eastern type of Rambouillet; champion at 1914 Ohio State Fair. *E*—Laramie Boy, champion ram at 1909 and 1910 International, from the King Brothers' flock. *F*—Old Bones, bred by R. A. Jackson, Dayton, Washington. This ram sheared 52 pounds of wool from a 12 months' growth period, as a two year old,—the record fleece for a Rambouillet.

under Australian conditions. Shortly afterwards he purchased some of the Spanish Merino sheep obtained at the Cape (South Africa) by Captain Waterhouse (who actually was the first to bring Merinos to Australia, although Captain MacArthur is generally credited with this). These sheep were from the Gordon flock at the Cape, which were descended from Spanish rams imported by Colonel Gordon. The results obtained with these sheep were such that Captain MacArthur was convinced that the Colony had a great future as a sheep and wool raising section, and it was through his insight and perseverance that the Merino's adaptability to Australian conditions was demonstrated, so that the wool produced there became famous throughout the world.

The Australian continent as a wool producer, received its first attention from the mother country through an interesting circumstance. Captain MacArthur and one Colonel Paterson had a quarrel, which resulted in a duel in which Paterson was seriously wounded. MacArthur was arrested by the authorities and ordered to proceed to England. Thus MacArthur went back to England, and seemingly was lightly dealt with, for he gave valuable testimony before a commission which was investigating the woolen industry. He had with him samples of wool, probably from the Gordon Merinos, which were very highly regarded, and which the mother country accepted as proof that here in Australia were the makings of a wonderful wool producing country. However, the residents of the sparsely populated Australia of that time were not interested in the production of wool, but only wanted some mutton to eat. The first sheep were therefore used for mutton rather than for wool, which was also the case in the early days of many of our own western states. As will be noted later, sheep formed a large part of the meat supply of the Spanish troops of Coronado on their march of conquest in the southwestern states in the sixteenth century. In 1822 the English Society of Arts awarded Captain MacArthur a gold medal for being the first to import a quantity of wool from Australia.

In the following quarter of a century numerous flocks of Merino sheep were established in Australia and Tasmania, and the foundation of the noted breeding flocks of later years was firmly rooted. What a marvelous change in that country which a few short years before had been regarded as only fit for felons! By the year 1840 half of the area of the new state of New South Wales had been occupied by sheep stations,[7] and this state was well on its way to its heritage as one of the greatest stud and commercial sheep and wool breeding districts of the country. Tasmania also became famous as a stud sheep breeding ground, and the superfine wool of Tasmania was without a peer in the Antipodes. Here it was that the greatest breeding families of sheep in Australian Merino history were developed and their blood disseminated to the great benefit of the entire sheep industry in that part of the world.

### South Africa, 1724

The Dutch government in 1724 had imported a few Merino sheep to the Cape, but although the value of the Merino wool was acknowledged, it was thought to be ill adapted to the rather warm climate of the Cape. Further it produced only a small amount of mutton, of poor quality, and produced no grease or tallow, an important product of the native fat tailed sheep. So the Merino found little favor among the Dutch farmers, and it was not until after these colonies were ceded to Britain that the Merino received any extensive trial in South Africa. Colonel Gordon, the last of the Dutch commandants, in 1785 introduced to the Cape a few Merinos which had been presented to the Dutch Government by the Spanish Crown. The descendents of these sheep were later sold to form the foundation stock of the MacArthur flock in Australia.

Lord Somerville became Governor of

the new English colony at the Cape. He had formerly obtained Merinos for King George III in Portugal and hence was well acquainted with the Merino sheep. He lost no time in bringing in to the Cape several importations of Merinos from England. They thrived and produced a good commercial quality of wool only in the most favored districts around Port Elizabeth, Durban, and parts of the Transvaal. During the last thirty years some excellent flocks of breeding stock have been established in favored localities through importations from Australia, and at the present time the breeding stock of South Africa compares favorably with that of other countries.

**South America, 1794**

The early livestock husbandry in Argentina was confined exclusively to cattle raising, and the powerful cattlemen did not encourage any intrusion of their pampas pastures by the agriculturist or sheep farmer. In 1587 Don Juan Torres de Veray Aragan introduced 4,000 Spanish sheep from Peru, which were distributed in various provinces of the Argentine.[10]

At the time of the conquest of the Incas in Peru (1533), they possessed an indigenous sheep which was appreciated by conquered and conqueror alike. These sheep were widely distributed throughout the different countries, being trailed to Asuncion, hence to Paraguay, and then to the provinces of the Argentine.

The first Merinos to come direct to the Argentine from Spain were brought to what is now Uruguay, then a part of the River Plate Viceroyalty, by Don Manuel Jose de Labarden in 1794, the same year that Captain Waterhouse took Merinos to Australia. The Argentine Merinos, however, were not so fortunate as their Australian relatives, and as nothing further was heard of them, it can safely be assumed that the small group of 10 rams and 20 ewes all were lost without any appreciable effect on the sheep population of the country.[10]

In the latter part of the eighteenth century various lots of Merinos were smuggled out of Spain by traders and taken to Buenos Aires. These sheep were sorely neglected and degenerated in a few years, so that little improvement was made in the native flocks. The earliest sheep descended from Merinos were miserable and undersized, with drooping rumps and harsh, "doggy" wool; and weighing a paltry 45 pounds. Their fleeces weighed only two pounds in the greasy condition. They were really the poorest individuals that could be imagined, producing neither good mutton nor wool.[15] However, in later years the Merino of Argentine and Uruguay has become much improved, so that today they produce a wool of very good quality, and the Merino classes at the great Palmero show at Buenos Aires would do credit to any country.

**Russia and Crimea, 1802**

Merino sheep was introduced into Russia in 1802 by a Frenchman, Monsieur Rouver, who because of bankruptcy was forced to flee from Malaga. He had previously traveled in Spain, and when he migrated to Russia, he was at once struck with the possibilities of sheep raising on the broad steppes of southern Russia. He convinced officials of the Russian Government of the value of Merino sheep, and received a grant of land and a considerable amount of money for which he was to introduce Merino sheep into Crimea. He went back to Spain, and through the Russian Minister applied for Spanish sheep, but the Spanish Government was adamant. He had given up and was about to return to Russia and report his failure when he was accosted by a mysterious individual who offered him sheep, but at an exhorbitant price.[15] He, of course, was glad to obtain Spanish sheep at any price, and an agreement was reached and 80 rams were smuggled out of the country. It is related that when within sight of the Russian coast Rouver had a presentiment of calamity

and so insisted upon an immediate landing that the captain of the ship finally yielded to his entreaties. No sooner had Rouver and his sheep been landed than the ship ran into a terrific storm and was wrecked with the loss of every man and animal left on board. Thus the golden fleece was saved, by a narrow margin, to graze the broad steppes of southern Russia.

The flockmasters of Crimea were mostly nomadic people, hence the quality of the Merino wool raised there was not the best. Merino sheep in Russia have been a degenerated race up to recent times, when a great many American and Australian Merinos have been imported in an effort to improve the wool of the Russian flocks.

### America

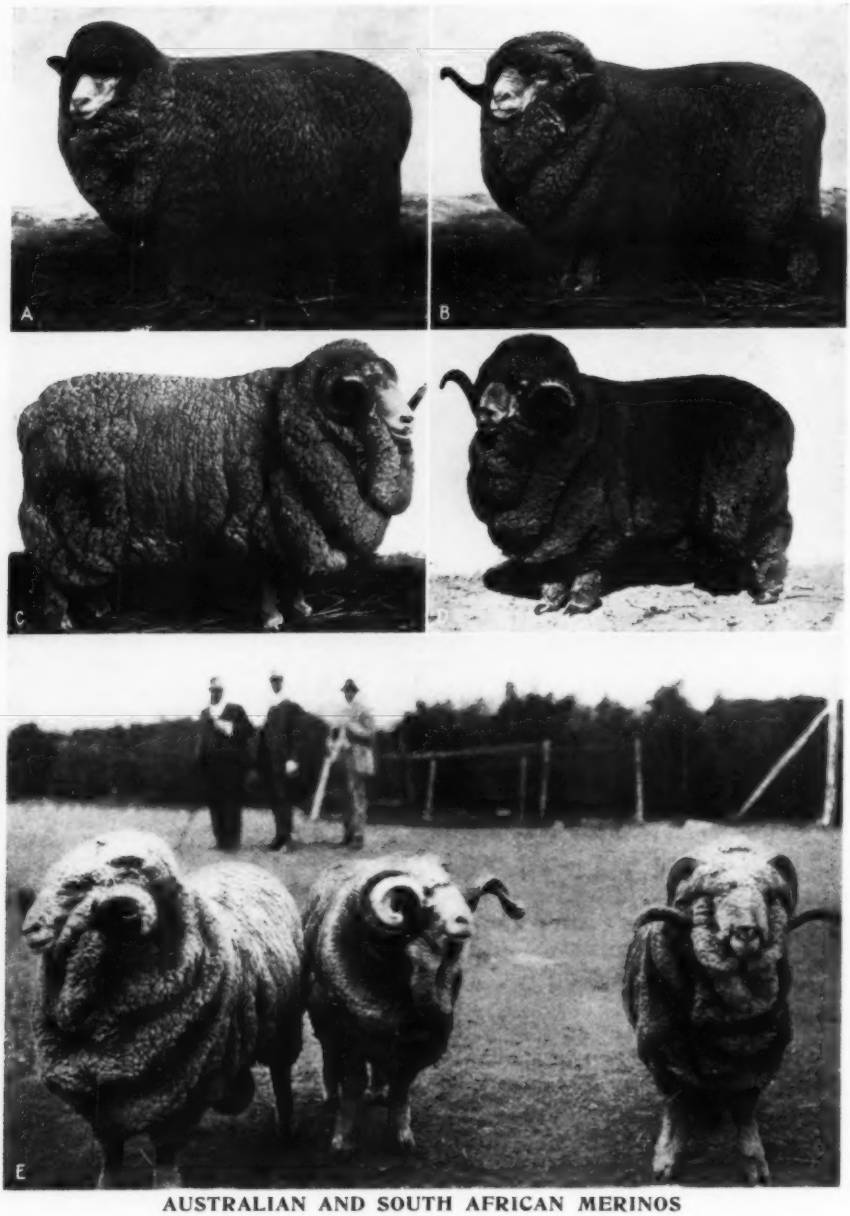
The history of sheep raising in the United States is practically identical with the introduction and development of the Merino sheep, which already had an illustrious history of achievement in producing the g o l d e n fleece, a coat of marvelous beauty and utility. Introduced into this country by far-seeing statesmen, who fortunately were agriculturally minded and saw its possibilities, it has steadily progressed, adapting itself to changing conditions, until today it serves as the foundation blood of our great grazing industry. It also retains considerable importance in the farming sections of the country, where steps have been taken to change its type to conform to changing economic conditions.

This breed has tasted the nectar of extreme popularity, when breeding rams brought thousands of dollars and wool sold for five dollars a pound; it has also drained the dregs of disfavor, when wool was practically worthless and sheep of purest Merino blood were sold to the rendering plant for around one dollar apiece.

The Tariff policies of the Government have often had a marked influence on the Merino wool industry. Thus the special Sheep report of the Bureau of Animal Industry[3] states that the number of fine wool sheep in the United States declined from 200,000 in 1845 to 72,000 in 1865 largely because of a change in Tariff policy enacted in 1846. The American manufacturers of fine broadcloth were forced out of business by the competition of European goods and this resulted in a gradual change over to the manufacture of goods requiring medium and coarse wools. Unfortunately this expedient was only a temporary success. The manufacturers of the United States could not compete with their English rivals who had large quantities of the finest medium and coarse wools to work with. Consequently both fine wools and medium wools suffered the same fate in the United States and the sheep industry went into a marked slump.

These varied experiences have steadily molded the breed into types best suited to a great variety of conditions, until today there are types of Merinos adapted to many purposes, to a degree hardly found in breeds which have not been so favored with many generations of constructive breeding. Their type, however, has remained as rugged and set as the granite hills of Vermont, a state whose name has become a by-word of excellence in Merino sheep lore. Possibly the greatest tribute paid to the Merino breed was paid by my good friend H. L. Thilo, whose marvelous breeding work with the Mele breed of Germany has already been mentioned. He has always claimed that the type of the Merino was so set that it was most difficult to change it through selection so as to obtain the extreme mutton conformation which he desired. He proved his premise by the remarkable results he obtained by the use of a suitable English breed, the Border Leicester, in attaining this end in comparatively few years.

When fine wool soared in price from fifty cents to six dollars a pound, there was an immediate response in Merino breeding, and we find a sheep that originally sheared only nine pounds now produced nearly fifty pounds. Again, in later years, when larger and more robust sheep were in demand, the




**AUSTRALIAN AND SOUTH AFRICAN MERINOS**

**Figure 11**

*A* and *B*—Ewe and ram of modern Australian Merino. *C*—Ram that sold for $13,425 in July, 1918. *D*—The Grand Champion Strongwool Merino ram at 1918 Sydney Sheep Show. *E*—Type of South African Merino rams. Photo by South African Railways. Australia, with a population of only six million people, has today a sheep population of over a hundred million. The yield of wool per head in Austrailia 48 years ago was slightly more than four and one half pounds per head. Today the average yield is nearly nine pounds. The South African sheep population, much of it Merino, is about 40 million head, or 84 sheep per square mile.

Merino body weight increased from 100 to 300 pounds. Some breeders desired all of the wool which could be packed on the sheep, and they set out to obtain as many pounds from a shearing as possible. They could obtain this result by breeding for excessive yolk or grease and to put as many wrinkles in the skin of the sheep as it would form. Their ideal of breeding, which has been so aptly described by German writers as *one-sided* breeding, led only to disaster, for they obtained a sheep totally unsuited to any but the most pampered conditions, and this type of sheep, like its degenerated cousin of Saxony, could not prosper and thrive, and gave way to a sheep which had a better proportioned set of utility characters.

Other breeders tried to combine fineness and length of staple and in so doing lost in weight of fleece as well as in body conformation. Yet others tried to obtain massive size, and found that these sheep were deficient in other characters which were absolutely necessary to fit into a profitable sheep industry. Overemphasis of any single character, or combination of two or three characters of body or fleece, has led to unsatisfactory results. A breeder, in order to maintain a satisfactory and profitable type of sheep which is least affected by the whims of fashion as reflected by the prices obtained at markets and sales, must maintain a balanced combination of the utility characters as shown in body conformation and fleece.

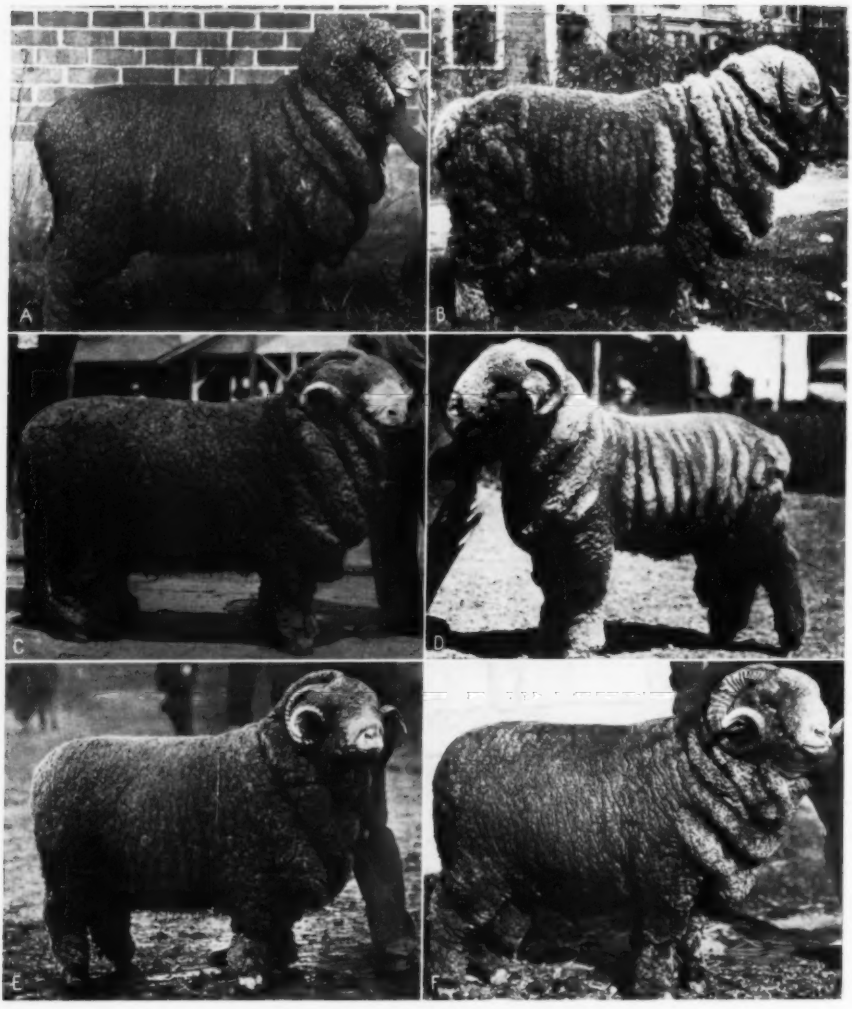
*Rambouillets in the United States, 1893*

At the time when many Merino breeders were overemphasizing fleece characters to the neglect of body conformation and ruggedness of constitution, a few French Merinos were introduced into the United States. They did not gain much favor at first, for the Merino breeders were not at all favorable to the "elephantine Merinos" as they were called. It was not until the Columbian Exposition of 1893 at Chicago that they were accepted as a valuable type of sheep. When touring Europe in 1880, Mr. Markham, of New York, had called on many of the Merino breeders in France and Germany, among whom was Baron von Homeyer of Germany.[14] He became a great friend of Baron von Homeyer and also became thoroughly appreciative of the excellence of his Rambouillet sheep. A few years later Baron von Homeyer sent some of his Rambouillets to Mr Markham as a present, and before the Columbian Exposition sent several more which Mr. Markham was to dispose of on consignment. These sheep possessed excellent breed and fleece characters in addition to their large, well proportioned bodies and created a sensation at the Chicago Exposition. Many of the breeders were very much interested in them, and the western flockmasters were intensely interested in a sheep that carried a good type of fleece along with a body conformation marvelously proportioned for its great size. They were greatly impressed with the fine heads with their typical setting of horns, which later became known as the distinguishing characteristic of the so-called von Homeyer type. Michigan and Ohio rapidly became breeding centers for these von Homeyer Rambouillets, and in a few years their blood spread rapidly throughout the country, until today we find few flocks of Rambouillets that do not have some of the von Homeyer blood.

*Balancing the Type*

The history of Merino sheep, as well as many other breeds of livestock, is full of striking examples of the folly of overemphasis of one or two characters of body or fleece. A system of breeding which seeks to place the *most pounds of clean wool of a desirable quality* on a *body which is robust and quite desirable for meat* is the ideal of all sheep breeding. The sheep breeder must keep this ideal continually before him in order to enjoy a moderate degree of success through all kinds of marketing conditions.

For the production of intermediate types of Merinos, it has been necessary



**RECENT AMERICAN MERINOS**

**Figure 12**

*A*—"Lady Wyoming," first prize yearling Rambouillet ewe at 1916 International Livestock Show,—a good "B type" Rambouillet. *B*—A Vermont type Rambouillet of 1921. *C*—"King Big Chief" Rambouillet ram sold for $1,300 at 1917 Salt Lake City Ram Sale. Weight 375 pounds; length 5 feet, 8½ inches; girth, 6 feet, 7 inches; height, 3 feet, 6 inches. *D*—"I Am," the 9 months old Rambouillet ram bred by A. R. Cox, which sold at the Salt Lake Ram Sale for $2,000 in 1927. This is the highest price paid in U. S. and perhaps in the world for a Rambouillet ram. *E*—Champion Rambouillet ram at International and American Royal Livestock Shows in 1925. Bred by King Brothers, in Laramie, Wyoming. *F*—Champion Rambouillet ram at 1932 International Livestock Show, bred by University of Wyoming.

to maintain extreme wool-type Merinos to supply blood to bolster up the wool characters of the breed. However, experience with the old type Merino in which wool type has been perhaps too greatly emphasized, showed that in breeding a dual-purpose sheep the Merino type is too set to respond to selection within the breed, and the greatest success has followed the use of other breeds of sheep with markedly different wool and body types. The most noted instance is the case of the Mutton Wool or Mele sheep of Germany, which is the result of crossing German Combing Wool ewes with Border Leicester rams.

### *Treks Across the United States 1860-1885*

During the early history of the Merino in the United States, many individuals of this hardy breed undertook what is probably one of the longest treks on record in traveling the 2,500 miles from the extreme eastern states to the West Coast. The writer has detailed accounts of one of these treks, and we shall now travel the early westward trail with the hardy Merinos.

The Patterson flock of New York played a most important part in the distribution of the American and French Merinos throughout the West Coast, and this flock also sent several shipments to Australia. In 1861 Mr. Patterson decided to trail his flocks and herds overland to California.[6] He shipped 600 purebred Merinos and 70 purebred Shorthorns by rail from New York State to St. Joseph and from there they went by boat up the Missouri river to Nebraska City. From this frontier settlement they outfitted and turned their heads westward, beginning the long trek on the first of May in order to take advantage of the lush grass and plentiful water available during the spring and summer months. Through Wyoming they found abundant grass of excellent fattening quality, and the stock put on considerable flesh.

The route of this trek was along the Platte river, crossing the South Platte river at Julesburg, and then up the North Platte to the famous Fort Laramie. They crossed the North Platte river near where Casper now stands and left the river to cross over the divide to the Sweetwater country, following it up to the continental divide over the so-called Landers trails, which crossed the continental divide at an elevation of 8,000 feet at a point 40 miles north of the old gold camp at South Pass City. They were now in the Green River valley and crossed over the Piney, La Barge, and Smith's Fork, following approximately the route of the so-called Sublette cut-off used by trappers and pioneers in the early days of this part of the country. They struck the Snake river at American Falls in Idaho and crossed the Goose Creek mountains over to the Humboldt river, following it to the "Big Bend" and then traveled 80 miles across the desert to Honey Lake Valley. This was the only hazardous part of the trip, and they were forced to travel at night in order to avoid heat and thirst. They arrived at Susanville, California and the drovers thoroughly enjoyed the first fresh beef they had tasted in five months, for their fare had consisted of beans, bacon and hard biscuits. From Susanville they traveled across the Sierra Nevada mountains and followed down the Feather River to Oroville and Marysville and finally arrived at their destination near Sacramento on October 8, 1861, after a trip of five months and eight days. One-fourth of the sheep and one-fifth of the cattle had been lost, but the horses were healthy, although tired and thin, and the men had come through the trip without mishap.

In such a manner were a group of Merinos introduced into California. These Merinos were, at a later date, to play a most important part in Merino breeding, not only in California, but also in other western states and even in far distant Australia. Mr. Patterson shipped other sheep by boat via Panama in 1859 and 1860, but the cost was

**MERINOS ON THE RANGE—AUSTRALIA**

**Figure 13**

In the world's open spaces, with no cover but the sky, the range Merino spends its life. The breed survives alike winter storms and summer heat, with temperatures varying from fifty degrees below zero to a hundred degrees above. In this harsh environment the breed has grown strong,—the Golden Fleece long and fine, so that today the Merino may deservedly be called the universal breed. Photograph courtesy U. S. Department of Agriculture.

very high ($100.00 in freight for each sheep) and only the enormous prices paid for Merino rams in California made such a procedure profitable. Merino rams quite often sold in California at this time for $1,000.00 a head.

*Eastward Treks*

In the '80's many sheep of Merino blood, principally wethers, were trailed eastward from Oregon and California and obtained a nice profit for the drovers when sold in Wyoming and other states to the East. The writer has in his possession the diary of one of these drovers who trailed sheep from Pendleton, Oregon, to Laramie City, Wyoming, in 1882, and as this diary gives typical and interesting information concerning these drives, we shall now join the trail flock.[8]

The first entry in the diary is dated May 27, 1882, and the last entry is on September 16th of the same year. Twenty-three thousand head of Merino wethers were purchased at Pendleton at a cost of $1.50 a head and were contracted at $3.50 each delivered in Laramie. These sheep were divided into three trail bands. Each band had a grub wagon, which was driven by the cook, a foreman and three men, making five men in all with each band. They had dogs to help keep the sheep moving. Out of the fifteen men who started on the trail only three finished, the rest tiring of the job and quitting. The dogs became so sore footed that they were useless in rounding up the band. However, the sheep arrived in Laramie in good shape, only 820 head being lost out of the 23,000, which was lower than the estimated loss of 1000. These sheep were all of the Merino type,—the type supposed to be the best adapted for that purpose.

The foreman on this drive received a wage of $50.00 a month and the other men, including the cook, drew $40.00 a month. They always had plenty of mutton to eat, and when they met up with a cattle outfit they traded mutton for beef. The grub wagon contained all kinds of canned goods, potatoes, tea, sugar, coffee, flour, bacon, and other non-perishable goods. They were able to replenish their supplies at different points along the route. Mr. Evans mentions that in 1882 there were large numbers of livestock of all kinds on the trail. He thinks that probably more stock was on the trail during this year than any other. At any rate, stock driving was conducted on such a large

scale that the prices of all types of livestock in Oregon began to increase, and the differential between the Oregon and Wyoming prices diminished to such a point that trailing rapidly declined. This is the same situation, and is probably due to the same causes, as the decline of cattle driving from Texas to Wyoming and Montana at approximately the same time.

### *Native Sheep of the West*

The first domestic sheep to see the rolling plains of the West were probably those in the "fresh meat on the hoof" supply of the Spanish explorer Coronado in 1540 when searching for the famed Cities of Cibola.[2] Coronado landed in Mexico and came up through what is now Chihuahua, on through the Rio Grande country and up into the present state of New Mexico. Some of his followers were left behind to establish Spanish settlements, but were harassed by the Indians, and the settlements were not permanent. Some of the sheep undoubtedly came into the possession of the Indians, for we find them doing their first woolen weaving shortly after this, their former work having been mostly with cotton.

The general assumption has been that all sheep coming from Spain must have been Merinos, and that the common sheep of our western states in early days were degenerated Merinos. However, a careful analysis of the present Navaho type of sheep, as well as a consideration of the habits and requirements of the Spanish troops on the march, points strongly to the fact that the sheep which accompanied the Spanish troops, and thus formed the foundation of the sheep of the West, were taken along to *furnish meat*. Furthermore pure Merinos were so carefully protected by the Spanish crown that it is very unlikely that they would let noble Merinos be sent out to furnish meat for the Spanish troops.

A description of the early types of sheep brought to California by the Missions states that they were in part degenerated Merinos and in part descendants of the unimproved Churro long wool breed of Spain and in part crosses of these two types.[3]

A description of the sheep accompanying Coronado's expedition states that they were "little black beastes with wool and hornes" (cited by Amsted[2] from Winship).

The Churro sheep were larger and heavier than the Merinos, and carried a coarse fleece five to eight inches long. This breed is found throughout Spain and is the favorite of the small land owner. The Churros are supposed to have been improved by the use of English Cotswolds which were brought to Spain in the fifteenth century to lengthen the staple of the coarser wooled breeds.[16]

The origin of the present type of Navaho sheep is shrouded in mystery. However, the original type of Navaho sheep as they existed prior to the middle of the last century was almost entirely exterminated at the time of the Navaho Revolt in 1860. The War Department later gave a contract to a New Mexican citizen to replace these sheep, but where he obtained the replacements is not definitely known.

### The Merino's Present Status

The Merino breed was the one used to improve the native sheep in all countries. First it was taken to Germany and crossed on their native sheep. The same process occurred in other European countries, South Africa, Australia, and the United States. A careful study of the history of the most important English mutton breeds, such as the Southdown and Ryeland, shows that they owe their excellent quality of fleece to their Merino blood.

The value of Merino blood in the range flocks of the West is widely acknowledged, and at the present time there is a widespread opinion that Merino blood is a requirement for the best health and performance in feeding lambs. There are many indications that point to increased interest in Merino sheep of various types.

Western rangemen have found that Merino blood is invaluable for main-

taining certain essential characters, such as gregariousness and ruggedness, in their flocks. Lamb feeders also find that the pure Rambouillets and certain types of Merinos furnish good mutton, and, in a great many cases, that a certain amount of Merino blood in the lambs they are fattening is very valuable in obtaining thrifty, healthy lambs that will make good use of the feed given to them, especially in utilizing the roughage part of the ration.

The Merino sheep from the earliest times has been the aristocrat of the sheep family, for it has enjoyed the patronage of rulers and kings of many lands. They have rendered it the homage due it for the wealth produced with its golden hoofs and its justly celebrated golden fleece. It has treked from its original home in the cradle of civilization to all of the nooks and crannies of this great globe, and its influence has been felt wherever sheep are raised. It has given large rewards to those who have had the courage and foresight to introduce it into new lands It may well be called the universal breed

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